S. HRG. 100-348

SOLAR DEVELOPMENT INITIATIVE ACT OF 1987 AND THE RENEWABLE ENERGY AND ENERGY CONSERVATION COMPETITIVENESS ACT OF 1987

HEARING

BEFORE THE

SUBCOMMITTEE ON
ENERGY RESEARCH AND DEVELOPMENT

OF THE

COMMITTEE ON
ENERGY AND NATURAL RESOURCES
UNITED STATES SENATE

ONE HUNDREDTH CONGRESS

FIRST SESSION

ON

S. 1320

TO PROVIDE ADEQUATE FUNDING LEVELS FOR SOLAR ENERGY RESEARCH AND DEVELOPMENT, TO ENCOURAGE FEDERAL PROCUREMENT OF SOLAR ENERGY SYSTEMS, TO ENCOURAGE FEDERAL LOANS FOR SOLAR ENERGY EQUIPMENT, TO ENHANCE THE INTERNATIONAL COMPETITIVENESS OF THE SOLAR INDUSTRY, AND FOR OTHER PURPOSES

S. 1554

TO PROVIDE FEDERAL ASSISTANCE AND LEADERSHIP TO A PROGRAM OF RESEARCH, DEVELOPMENT AND DEMONSTRATION OF RENEWABLE ENERGY AND ENERGY CONSERVATION TECHNOLOGIES, AND FOR OTHER PURPOSES

AUGUST 6, 1987

Printed for the use of the
Committee on Energy and Natural Resources

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SOLAR DEVELOPMENT INITIATIVE ACT OF 1987 AND THE RENEWABLE ENERGY AND ENERGY CONSERVATION COMPETITIVENESS ACT OF 1987

THURSDAY, AUGUST 6, 1987

U.S. SENATE,
SUBCOMMITTEE ON ENERGY RESEARCH AND DEVELOPMENT,
COMMITTEE ON ENERGY AND NATURAL RESOURCES,
Washington, DC.

The subcommittee met, pursuant to notice, at 1:38 p.m., in room SD-366, Dirksen Senate Office Building, Hon. Wendell H. Ford, presiding.

OPENING STATEMENT OF HON. WYCHE FOWLER, JR., A U.S. SENATOR FROM THE STATE OF GEORGIA

Senator FOWLER. Ladies and gentlemen, I think we will begin. I want Senator Ford to hear from the distinguished Senator from Hawaii. Just to facilitate things for him and for Senator Matsunaga when he arrives, I think I'll go ahead and put my opening statement in the record.

As most of the people in this room know, the American taxpayers have already spent over $4 billion during the last 20 years to develop alternative renewable energy sources to meet future energy needs. But the need, in my opinion, is not futuristic. Our dependence upon imported oil is the same as it was during the gas lines of the Arab oil embargo in 1973, and it is rising steadily.

Today, as we speak, American warships are engaged in a dangerous mission trying to defend the flow of oil in the narrow straits of the Persian Gulf, sailing straight through the middle of the Iran-Iraq war that has raged for at least 7 years now with a minimum of one million casualties to date.

But even as we go on this unpredictable course we are flirting with even greater danger in the future. The fact that 60 percent of the world oil reserves are in the volatile Middle East should tell us something about what we have to look forward to. The fact that in 1986 one-half of the world's oil supply had already been consumed, with the rate of consumption quadrupling in the last quarter century, should tell us something even more disquieting.

The message, at least to me, is clear. There is no way we're ever going to have strong national security as long as we are dependent on other countries for our oil. There is no way we are going to control our own economic destiny if we are not energy self-sufficient.

That is why we spent that $4 billion over the last 20 years, to develop renewable resources in solar, wind, ocean, geothermal, bio-

mass, and last but certainly not least, conservation. But when the taxpayers look at our present situation, they, I think, often wonder where all that money went.

It went to research and development that taught us much about how to harness these more dependable energy sources that are controllable neither by the sheiks nor by the ayatollahs. It went to conservation programs that were extremely successful in reducing energy demand. It went to alternative energy technologies that showed great promise.

Some have been developed to the extent they could be competitive in today's markets. Others are not far away. We know how to begin reducing our dangerous dependence on foreign oil, reducing our reliance on fuels that harm our environment.

But that is where it has all stopped, so it seems the record should reflect, under this Administration.

While other countries have seen the wave of the future and begun investing heavily in the development of renewables, we have all but eliminated our programs, leaving the work we in the United States of America began, undone. In the meantime, we've lost the market and technological lead we held, for instance, in wind power, to the Danes, our lead in photovoltaics to the Japanese.

We're letting a great opportunity for which we worked hard slip away. We are losing the race because our government in all of its components—the Congress and the Executive—is not providing the leadership necessary to plan for the future.

Market forces do not plan for the future. We have to. We have to convince our people that renewables are not some science fiction program, that they are not needed for some world far in the future, but that work has to continue now.

At least I think we are foolish to not push ahead when we already have the investment, we've already made it, and already possess the know-how.

In short, we've got to develop a rational and coherent energy policy for this country. Solar and other renewables can make a great contribution.

The legislation we will be discussing today can start us down the road towards a policy that will not squander that promise.

I am pleased to announce that in addition to the initial co-sponsors of this legislation, the majority leader, Senator Byrd, has joined today. He made a very strong statement on the Floor today about the need for a comprehensive energy policy for our country. Senator Kerry and Senator Kennedy of Massachusetts have also joined in.

Mr. Chairman, let me thank you for your leadership in these matters, and for allowing us to go forward with this legislation by these hearings. We certainly welcome you and any statements that you might make.

OPENING STATEMENT OF HON. WENDELL H. FORD, A U.S. SENATOR FROM THE STATE OF KENTUCKY

Senator FORD. Thank you, Mr. Chairman.

Senator FOWLER. I was trying to get my statement out of the way so you could hear from the distinguished Senator from Hawaii.

Senator FORD. I'm going to keep him there for a little while. I've got you where I want you now. You just sit there for a few minutes.

Very frankly, I am very pleased with the two bills that are before us today. These bills are very timely as the Committee on Energy and Natural Resources begins to formulate a policy to meet the future needs of our nation.

It seems that this country only reacts. It has a very, very difficult time acting. Only when those lines are backed up block after block in front of the service stations do we have any kind of interest in this country as it relates to trying to do something about it. Then they run up here and say, why haven't you done all this?

So these bills are an indication. The speeches on the Floor at noon today indicate the interest that is now being shown. I think the Persian Gulf is indicative of what is going on, and we're beginning to react.

Our levels of import of foreign oil is increasing almost daily. Our level of domestic production of crude is continuing to decline. There is some effort out there. I heard good news yesterday that it's hard to buy a used pipe for a well. So maybe we're going to see some new movement as it relates to the steel industry.

Research and development on alternative energy sources has been cut by this Administration by 80 percent since 1980. It is urgent, in my opinion, for us to act today to avoid a crisis in the future, and I don't mean too far in the future. I mean in the next decade, in the 1990's.

For these reasons I am pleased that both Senator Bumpers, the sponsor of S. 1320, and my good friend Senator Fowler, the sponsor of S. 1554, have taken the initiatives that they have. In particular I would like to compliment my colleague Senator Fowler, the distinguished Senator from Georgia, and thank him personally and publicly for his efforts on S. 1554, which, by the way, I am an original co-sponsor of.

I am very pleased at his interest. And as vice chairman of the subcommittee he will hold the hearings late. I usually leave early and he's usually early and will leave late. So that will work out just right.

Senator Matsunaga, we will be delighted to listen to you.

[The prepared statements of Senators Ford, Bumpers, Bingaman, and Domenici, and the texts of S. 1320 and S. 1554 follows:]

STATEMENT OF SENATOR WENDELL FORD

CHAIRMAN

SUBCOMMITTEE ON ENERGY RESEARCH AND DEVELOPMENT

HEARING ON S. 1320 AND S. 1554

AUGUST 6, 1987

I AM PLEASED TO BE HERE TODAY TO HEAR THE TESTIMONY ON TWO VERY IMPORTANT ENERGY BILLS. BOTH S. 1320, THE "SOLAR DEVELOPMENT INITIATIVE ACT OF 1987" AND S. 1554, THE "RENEWABLE ENERGY & ENERGY CONSERVATION TECHNOLOGY COMPETITIVENESS ACT OF 1987" ARE NECESSARY ELEMENTS OF ENERGY POLICY. THESE BILLS ARE VERY TIMELY AS THE COMMITTEE ON ENERGY AND NATURAL RESOURCES BEGINS TO FORMULATE A POLICY TO MEET THE FUTURE ENERGY NEEDS OF OUR NATION.

OUR LEVEL OF IMPORTS OF FOREIGN OIL IS CONTINUING TO INCREASE, AND OUR LEVEL OF DOMESTIC PRODUCTION OF CRUDE OIL IS CONTINUING TO DECLINE. RESEARCH AND DEVELOPMENT ON ALTERNATIVE ENERGY SOURCES HAS BEEN CUT BY THE ADMINISTRATION BY 80 PERCENT SINCE 1980. IT IS URGENT FOR US TO ACT TODAY -- TO AVOID A CRISIS IN THE FUTURE. AND I DON'T MEAN TOO FAR INTO THE FUTURE -- I MEAN IN THE NEXT DECADE -- IN THE 1990'S.

FOR THESE REASONS, I AM PLEASED THAT BOTH SENATOR BUMPERS, THE SPONSOR OF S. 1320 AND SENATOR FOWLER, THE SPONSOR OF S.1554, HAVE TAKEN THE INITIATIVES THAT THEY HAVE TAKEN. IN PARTICULAR, I WOULD LIKE TO COMMEND MY COLLEGUE FROM GEORGIA AND THANK HIM FOR HIS EFFORTS ON S. 1554, OF WHICH I AM AN ORIGINAL CO-SPONSOR.

I AM LOOKING FORWARD TO THE TESTIMONY OF THE DEPUTY SECRETARY OF ENERGY, WILLIAM MARTIN, AND OUR OTHER KNOWLEDGABLE WITNESSES ON THIS SUBJECT.

STATEMENT OF SENATOR DALE BUMPERS

HEARINGS ON S. 1320 AND S. 1554

MR. CHAIRMAN, TODAY'S HEARING WILL COVER TWO PIECES OF LEGISLATION WHICH I BELIEVE WILL HELP THE UNITED STATES RETAIN ITS TECHNOLOGICAL LEAD IN SOLAR ENERGY AND OTHER RENEWABLE ENERGY SOURCES. S. 1320, THE SOLAR DEVELOPMENT INITIATIVE, IS INTENDED TO FURTHER SOLAR ENERGY RESEARCH, EXPAND DOMESTIC AND FOREIGN MARKETS, AND BUILD OUR DOMESTIC RENEWABLE ENERGY INDUSTRY. BY UTILIZING EXISTING FEDERAL PROGRAMS, THIS BILL IS DESIGNED TO BE OF PRACTICAL ASSISTANCE TO THE SOLAR ENERGY INDUSTRY AT MINIMAL COST TO THE FEDERAL TAXPAYER. S. 1554, THE RENEWABLE ENERGY AND ENERGY CONSERVATION TECHNOLOGY COMPETITIVENESS ACT, SETS GOALS AND PRIORITIES AND AUTHORIZES FUNDING FOR A SPECTRUM OF RENEWABLE ENERGY AND CONSERVATION RESEARCH AND DEVELOPMENT PROGRAMS. I AM PLEASED TO BE THE SPONSOR OF S. 1320 AND A COSPONSOR OF S. 1554 AND I LOOK FORWARD TO WORKING WITH SENATOR FOWLER AND OTHER INTERESTED COMITTEE MEMBERS ON THESE BILLS.

RENEWABLE ENERGY SOURCES ARE MAKING AND CAN CONTINUE TO MAKE AN IMPORTANT CONTRIBUTION TO THE NATION'S ENERGY POLICY GOAL OF A BALANCED AND DIVERSIFIED ENERGY SUPPLY SYSTEM AT A REASONABLE COST. THE CURRENT LOW OIL PRICES HAVE ALREADY CAUSED A DECLINE IN THE DOMESTIC PRODUCTION OF PETROLEUM AND AN INCREASE IN IMPORTS. THE ENERGY SECURITY STUDY RELEASED BY DOE STATES THAT

"KEY PROJECTIONS SHOW U.S. OIL IMPORTS INCREASING FROM 5.2 MILLION BARRELS PER DAY (ABOUT ONE THIRD OF THE NATION'S OIL CONSUMPTION) IN 1986 TO BETWEEN 8 TO 10 MILLION BARRELS A DAY IN THE 1990'S." THE PURSUIT OF A DIVERSIFIED ENERGY SUPPLY SYSTEM BECOMES EVEN MORE CRITICAL UNDER THESE CIRCUMSTANCES.

WHILE OTHER INDUSTRIALIZED NATIONS INCREASE THEIR COMMITMENTS TO SOLAR THERMAL AND PHOTOVOLTAICS TECHNOLOGIES, THE UNITED STATES IS RELYING ON LAISSEZ-FAIRE POLICIES FOR SOLAR ENERGY DEVELOPMENT. WE MUST KEEP OUR TECHNOLOGICAL LEAD IN SOLAR ENERGY IN ORDER TO MAINTAIN AN AGGRESSIVE POSTURE IN INTERNATIONAL MARKETS. A STRONG RESEARCH AND DEVELOPMENT PROGRAM IS ESSENTIAL TO THIS EFFORT. WHILE FEDERAL SUPPORT HAS BEEN CUT BY 70 PERCENT OVER THE LAST FIVE YEARS FOR THE INTERNATIONAL, PHOTOVOLTAICS, SOLAR BUILDINGS AND SOLAR THERMAL PROGRAMS, OUR INTERNATIONAL COMPETITORS HAVE INCREASED THEIR FUNDING. BETWEEN 1977 AND 1985,ACCORDING TO INTERNATIONAL ENERGY AGENCY DATA, JAPAN'S EXPENDITURES FOR SOLAR RESEARCH HAVE INCREASED EIGHT FOLD AND WEST GERMANY'S SOLAR BUDGET HAS TRIPLED. OTHER COUNTRIES SHOW SIMILAR TRENDS.

BOTH BILLS BEFORE THE SUBCOMMITTEE AUTHORIZE AT LEAST LEVEL FUNDING FOR THE DEPARTMENT OF ENERGY RESEARCH AND DEVELOPMENT PROGRAMS FOR A THREE YEAR PERIOD. BOTH BILLS ALSO ADDRESS THE NEED IDENTIFIED IN PREVIOUS SENATE HEARINGS FOR RESEARCH WITH PRACTICAL, SHORT TERM COMMERCIAL APPLICATIONS. MY LEGISLATION

WOULD DIRECT DOE TO CONSULT WITH THE SOLAR INDUSTRY TO DEVELOP A PROGRAM OF COOPERATIVE FEDERAL /INDUSTRY RESEARCH IN THIS AREA.

SECOND, THE SOLAR DEVELOPMENT INITIATIVE ADDRESSES THE NEED FOR THE UNITED STATES TO EXPAND THE MARKETS FOR SOLAR ENERGY TECHNOLOGIES, SO THAT OUR INDUSTRIES CAN SCALE UP THEIR PRODUCTION FACILITIES AND SUBSEQUENTLY CUT THEIR COSTS. THE LEGISLATION OFFERS TWO CONCRETE ACTIONS TO EXPAND FEDERAL PROCUREMENT - (1) EDUCATING PROCUREMENT OFFICERS ABOUT THE SUCCESSFUL SOLAR DEMONSTRATION PROJECTS INSTALLED IN FEDERAL BUILDINGS AND (2) APPLYING THE DEFENSE DEPARTMENT'S SOLAR PROCUREMENT POLICIES TO OTHER FEDERAL AGENCIES.

THIRD, THE LEGISLATION DIRECTS THE EXISTING FEDERAL LOAN PROGRAMS FOR SMALL BUSINESS, DEVELOPMENT, AND EXPORTS TO BE MORE RESPONSIVE TO THE NEEDS OF THE SOLAR INDUSTRIES. THESE PROGRAMS HAVE TENDED TO BE MORE AVAILABLE TO CONVENTIONAL ENERGY DEVELOPMENT AND NEED TO BE OPENED TO NEW TECHNOLOGIES.

THE BILLS BEFORE US TODAY PROVIDE A STARTING POINT FOR A RENEWED CONGRESSIONAL COMMITMENT TO SOLAR ENERGY AND OTHER RENEWABLE ENERGY SOURCES. I LOOK FORWARD TO HEARING THE WITNESSES TODAY AND HOPE THAT THEY WILL PROVIDE THE SUBCOMMITTEE WITH SPECIFIC COMMENTS AND SUGGESTIONS ON THE LEGISLATION. THANK YOU MR. CHAIRMAN.

Statement of Senator Jeff Bingaman
S. 1320 and S. 1554
August 6, 1987

I thank the Chairman for holding this hearing to receive testimony on two important pieces of legislation dealing with renewable energy and energy conservation legislation -- the Solar Development Initiative Act of 1987 (S. 1320) and the Renewable Energy and Energy Conservation Technology Competitiveness Act of 1987 (S. 1554). We must encourage the advancement of renewable energy and energy conservation research and development technologies through federal support and in cooperation with the private sector.

Our current energy situation finds us with a growing dependence on imported oil -- nearly 40 percent of our domestic requirements. Unfortunately, the Administration has not taken action to develop and implement a comprehensive energy policy that will allow this country to reduce its dependence on foreign crude oil. The responsibility of Congress to enact responsive energy policies and programs becomes critical in the absence of executive branch leadership. During the last three years every major industrialized nation has increased its federal research and development programs for biomass, solar, and wind energy

while the U.S. has drastically reduced our own programs. These cuts will seriously undercut our competitiveness in a potentially multi-billion dollar international market. I hope we are successful in providing the proper encouragement to expand the role of solar and renewable energy research and development as well as energy conservation. New Mexico has long played an integral role, through our National Laboratories, University, and private business in advancing alternative energy research and development, both here and abroad.

The legislative initiatives we consider today, will certainly move this country forward and help us reduce our dependence on fossil fuels. Enactment of this legislation also represents an important first step in reasserting a United State's role to assist our domestic renewable energy industries maintain their competitiveness and increase our share of world markets.

OPENING STATEMENT - SENATOR DOMENICI

GOOD AFTERNOON. ONCE AGAIN, I AM LOOKING FORWARD TO THE TESTIMONY AND DISCUSSIONS WE WILL HAVE TODAY CONCERNING THE ROLE OF THE DEPARTMENT OF ENERGY IN FOSTERING RENEWABLE ENERGY TECHNOLOGIES.

THE COMMENTS THAT TODAY'S WITNESSES WILL PROVIDE WITH RESPECT TO THE TWO BILLS BEFORE OUR COMMITTEE -- S. 1320 AND S. 1554 -- WILL BE MOST HELPFUL TO US IN FORMULATING POLICY GOALS IN THESE IMPORTANT ENERGY RESEARCH AREAS.

BEFORE WE BEGIN, I WISH TO REITERATE MY POSITION THAT WE MUST AVOID THE CREATION OF ARTIFICIAL CRUTCHES THAT HAVE PROVEN SO DETRIMENTAL IN THE PAST. FURTHERMORE, I WOULD LIKE TO PERSONALLY COMMEND THE DEPARTMENT FOR THE SUCCESS IT HAS HAD TO DATE IN ACHIEVING A TRULY MEANINGFUL WORKING PARTNERSHIP WITH THE LABS AND THE PRIVATE SECTOR. THIS PARTNERSHIP HAS ENABLED THE DEPARTMENT TO FORMULATE A BALANCED RESEARCH AND DEVELOPMENT PROGRAM THAT HAS BEEN VERY RESPONSIVE TO MARKET FORCES. THE DEPARTMENT HAS DEMONSTRATED REMARKABLE FLEXIBILITY IN ADJUSTING ITS PROGRAM ELEMENTS TO FOCUS IN ON THE KINDS OF RESEARCH AREAS THAT HOLD THE GREATEST PROMISE OF MAJOR TECHNOLOGIC BREAKTHROUGHS.

I HOPE THAT WE WILL NOT DESTROY THIS BALANCE BY IMPROPERLY MICROMANAGING THE DEPARTMENT'S PROGRAMS. RATHER, I WOULD PREFER TO IDENTIFY SPECIFIC AREAS WHERE LEGISLATION WOULD NURTURE THE ALREADY SUCCESSFUL PARTNERSHIP, SO AS TO ALLOW THE RESULTS OF THE RESEARCH AND DEVELOPMENT PROGRAMS TO FIND THEIR WAY INTO THE MARKETPLACE IN AS UNENCUMBERED A WAY AS POSSIBLE.

II

100TH CONGRESS
1ST SESSION

S. 1320

To provide adequate funding levels for solar energy research and development, to encourage Federal procurement of solar energy systems, to encourage Federal loans for solar energy equipment, to enhance the international competitiveness of the solar industry, and for other purposes.

IN THE SENATE OF THE UNITED STATES

JUNE 3, 1987

Mr. BUMPERS (for himself, Mr. FOWLER, Mr. DECONCINI, Mr. MATSUNAGA, and Mr. CRANSTON) introduced the following bill; which was read twice and referred to the Committee on Energy and Natural Resources, and, pursuant to rule XXV(1)(o)(1), ordered that if and when reported, referred to the Committee on Small Business

---

A BILL

To provide adequate funding levels for solar energy research and development, to encourage Federal procurement of solar energy systems, to encourage Federal loans for solar energy equipment, to enhance the international competitiveness of the solar industry, and for other purposes.

Be it enacted by the Senate and House of Representatives of the United States of America in Congress assembled,

SECTION 1. SHORT TITLE.

This Act may be cited as the "Solar Development Initiative Act of 1987".

SEC. 2. FINDINGS AND PURPOSE.

(a) FINDINGS.—The Congress finds that—

(1) a diversified and balanced energy resource base is important for the Nation's economic growth;

(2) renewable energy sources, including solar energy, can make a significant contribution toward minimizing the potential for undue dependence on any single energy source;

(3) recent energy trends, including increased imports of foreign oil, increased consumption of petroleum and declining domestic production of petroleum, have reaffirmed the importance of continued Federal support for, and encouragement of, solar energy technologies; and

(4) the international competitiveness of domestic solar thermal and photovoltaics industries depends upon maintaining our technological lead and providing development and marketing assistance to exporters of solar technologies.

(b) PURPOSE.—The purpose of this Act is to—

(1) establish multi-year funding levels for a Federal solar research and development program that will maintain current efforts and provide funding stability; and

(2) reaffirm existing Federal policies and establish new policies which promote and encourage investments

in solar energy technologies by the private and public sectors.

SEC. 3. DEPARTMENT OF ENERGY SOLAR RESEARCH AND DEVELOPMENT PROGRAM.

(a) IN GENERAL.—(1) It is the sense of the Congress that the authorizations provided in this section indicate the minimum levels for a solar research effort that is sensitive to the Federal deficit and also to the survival and growth of the solar energy industry in the United States.

(2)(A) There is authorized to be appropriated for the Solar Buildings Energy Systems program an amount not to exceed $8,000,000 in fiscal year 1988, $8,400,000 in fiscal year 1989, and $8,820,000 in fiscal year 1990.

(B) There is authorized to be appropriated for the Photovoltaic Energy Systems program an amount not to exceed $45,000,000 in fiscal year 1988, $47,250,000 in fiscal year 1989, and $50,000,000 in fiscal year 1990.

(C) There is authorized to be appropriated for the Solar Thermal Energy Systems program an amount not to exceed $30,000,000 in fiscal year 1988, $31,500,000 in fiscal year 1989, and $33,075,000 in fiscal year 1990.

(D) There is authorized to be appropriated for the International Solar Energy program an amount not to exceed $1,500,000 in fiscal year 1988, $1,575,000 in fiscal year 1989, and $1,655,000 in fiscal year 1990.

(b) SOLAR AND RENEWABLE ENERGY RESEARCH PROGRAM.—The Secretary of Energy is directed to consult with the solar energy industry to develop a complimentary program of solar and renewable research, development, and demonstration project which—

(1) have near-term commercial applications; and

(2) will enhance the international competitiveness of the solar and renewable energy industries.

The Secretary shall include the funding necessary to implement this program in the fiscal year 1989 budget.

SEC. 4. FEDERAL SOLAR BUILDINGS DEMONSTRATION PROGRAM.

(a) PROGRAM SUCCESSFULLY IMPLEMENTED.—Congress finds that the Secretary of Energy, in consultation with the Administrator of the General Services Administration, has successfully implemented a program to demonstrate in Federal buildings the application of solar heating and solar heating and cooling technology pursuant to part 2 of title V of the National Energy Conservation Policy Act (Public Law 95–619).

(b) INFORMATION ABOUT FEDERAL SOLAR BUILDINGS PROGRAM.—In order to more widely disseminate information about the Federal solar buildings program and the benefits of solar heating and solar heating and cooling technology, the Secretary of Energy shall establish a program to dissemi-

nate such information for Federal procurement officers and Federal loan officers which shall include site visits and technical briefings. The Secretary shall utilize existing funds for this program.

SEC. 5. INTERNATIONAL MARKET ENHANCEMENT.

(a) CONTINUATION OF ACTIVITIES BY THE COMMITTEE ON RENEWABLE ENERGY, COMMERCE, AND TRADE.—The Committee on Renewable Energy, Commerce, and Trade established by section 256(d) of the Energy Policy and Conservation Act (42 U.S.C. 6271 et seq.) shall continue its activities to coordinate the actions and programs of the Federal Government affecting commerce in renewable energy products and services.

(b) COMMERCE PROGRAMS.—It is the sense of the Congress that the programs established by the Secretary of Commerce under section 256(c)(1) of the Energy Policy and Conservation Act should be funded through the Department of Energy at a minimum level of $1,500,000 in fiscal years 1988, 1989, and 1990.

(c) AMENDMENT TO CARIBBEAN BASIN ECONOMIC RECOVERY ACT.—Section 212(c)(7) of the Carribbean Basin Economic Recovery Act (97 Stat. 387; 19 U.S.C. 2703(c)(7)) is amended to read as follows:

"(7) the degree to which such country is undertaking self-help measures to promote its own economic

development and energy self-sufficiency using locally available renewable resources;".

SEC. 6. FEDERAL PROCUREMENT.

(a) SECRETARY OF DEFENSE.—Section 2857(b)(1) of title 10, United States Code, is amended by inserting after "has the potential for" the following: "reduced energy costs".

(b) UTILIZATION OF SOLAR ENERGY BY OTHER FEDERAL AGENCIES.—The Secretary of State, the Secretary of Energy, the Secretary of Housing and Urban Development, the Director of the General Services Administration, and the Commissioner of the United States Postal Service shall require that the design of all new Federal facilities built under their respective jurisdictions shall include consideration of energy systems using solar energy or other renewable forms of energy in those cases in which use of such form of energy has the potential for significant savings of fossil-fuel-derived energy.

SEC. 7. AMENDMENT TO THE EXPORT-IMPORT BANK ACT OF 1945.

Section 7 of the Export-Import Bank Act of 1945 (12 U.S.C. 635e) is amended by adding at the end thereof the following:

"(c) Not less than .025 percent of the loan authority of the Bank shall be available only for solar and renewable energy loans.".

SEC. 8. SPECIAL ACTIVITIES OF THE OVERSEAS PRIVATE INVESTMENT CORPORATION

Section 234(e) of the Foreign Assistance Act of 1961 is amended—

(1) in the first sentence, by inserting after "cooperatives" the following: "and including the initiation of incentives, grants, and studies for renewable energy and other small business activities"; and

(2) by adding at the end thereof the following new sentence: "Administrative funds may not be made available for incentives, grants, and studies for renewable energy and other small business activities.".

SEC. 9. AMENDMENT TO THE SMALL BUSINESS ACT.

(a) Section 7(l) of the Small Business Act (15 U.S.C. 636(l)) is repealed.

(b) Section 7(a)(12) of such Act (15 U.S.C. 636(a)(12)) is amended to read as follows:

"(12) The Administrator may provide loans under this subsection to assist any small business concern, including startup, to enable such concern to design architecturally or engineer, manufacture, distribute, market, install, or service energy measures. Proceeds of loans under this paragraph

shall not be used for research and development. Not less than .025 percent of the loan authority provided under this subsection shall be available only for loans under this paragraph. The Administrator shall include a list of solar and renewable energy loans in an annual report to the Congress.".

(c) Section 7(a)(14) of such Act (15 U.S.C. 636(a)(14)) is amended to read as follows:

"(14) The Administrator under this subsection may provide extensions and revolving lines of credit for export purposes to enable small business concerns to develop foreign markets and for preexport financing. No such extension or revolving line of credit may be made for a period or periods exceeding 18 months. A bank or participating lending institution may establish the rate of interest in extensions and revolving lines of credit as may be legal and reasonable. The Administrator shall give due consideration to the export potential of solar and renewable energy products in implementing his authorities under this subsection and shall include a list of solar and renewable energy loan guarantees in an annual report to the Congress.".

○

II

100TH CONGRESS
1ST SESSION

S. 1554

To provide Federal assistance and leadership to a program of research, development and demonstration of renewable energy and energy conservation technologies, and for other purposes.

IN THE SENATE OF THE UNITED STATES

JULY 28 (legislative day, JUNE 23), 1987

Mr. FOWLER (for himself, Mr. MATSUNAGA, Mr. WIRTH, Mr. FORD, Mr. BUMPERS, and Mr. DECONCINI) introduced the following bill; which was read twice and referred to the Committee on Energy and Natural Resources

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A BILL

To provide Federal assistance and leadership to a program of research, development and demonstration of renewable energy and energy conservation technologies, and for other purposes.

Be it enacted by the Senate and House of Representatives of the United States of America in Congress assembled, That this Act may be cited as the "Renewable Energy and Energy Conservation Technology Competitiveness Act of 1987".

SEC. 2. FINDINGS AND PURPOSES.

(a) Congress finds that—

(1) a secure and diverse supply of energy is in the Nation's best interest, and it is appropriate for the Federal Government to sponsor a balanced program of energy research and energy technology development and demonstration to insure diverse supplies of energy by the year 2000;

(2) a strategic plan to pursue a program that balances Federal investments among energy supply and technology options is needed to assure that a well-managed, cost-effective research, development and demonstration program will be implemented;

(3) renewable energy resources and energy conservation technologies can make the energy sources of the United States secure and diverse with minimal environmental risks;

(4) the development and use of renewable energy and energy conservation technologies can significantly reduce United States dependence on foreign energy sources; however, the extent of such contribution is dependent upon increasing efficiencies and reducing costs of renewable energy and energy conservation technologies;

(5) energy for buildings consumes approximately 36 per centum of the total United States energy

supply, and approximately two-thirds of United States electricity is consumed in buildings;

(6) use of renewable energy and energy conservation technologies in buildings potentially could provide for a cost-effective increase in energy efficiency in the buildings' sector of as much as 30 to 50 per centum;

(7) the Federal Government, as the largest consumer of energy in the United States, should promote the effective use of renewable energy and energy conservation technologies;

(8) the technological lead of United States firms and their capability to compete with foreign renewable energy and energy conservation technology has declined in recent years, and many foreign firms are selling renewable energy and energy conservation technology in the United States;

(9) competitiveness of United States firms overseas depends in part on long-term, stable Federal support of research and development efforts to maintain United States preeminence in technology; it is also appropriate for the Federal Government to support nearer-term commercial and proof-of-concept demonstrations so that United States firms will have not only technology, but also products to market;

(10) the development and export of renewable energy and energy conservation products and technology can contribute positively to the balance of trade; and

(11) the volatility of world energy markets underscore the need for sustained levels of support for the research and development of renewable energy and energy conservation technologies.

(b) It is the purpose of this Act to direct the Secretary of Energy to pursue an aggressive national program of research, development and demonstration of renewable energy and energy conservation technologies in order to ensure a stable and secure future energy supply by—

(1) providing a long-term stable environment for renewable energy and energy conservation technology research and development activities through the establishment of long-term goals and multiyear funding levels;

(2) directing the Secretary to undertake initiatives to hasten the commercialization in the near term of renewable energy and energy conservation technologies;

(3) fostering collaborative research and development efforts involving the private sector through government support of a vigorous program of joint venture innovative projects; and

(4) promoting the use of renewable energy and energy conservation in buildings owned or leased by the Federal Government.

SEC. 3. DEFINITIONS.

As used in this Act the term "Secretary" means the Secretary of Energy.

SEC. 4. NATIONAL GOALS AND MULTI-YEAR FUNDING FOR FEDERAL WIND, PHOTOVOLTAICS AND SOLAR THERMAL PROGRAMS.

(a) The following are declared to be the national goals for the wind, photovoltaics and solar thermal energy programs currently being carried out by the Secretary under existing law:

(1) WIND.—(A) In general, the goals for the Wind Energy Research Program include improving design methodologies and developing more reliable and efficient wind turbines to increase the cost competitiveness of wind energy. Research efforts shall emphasize—

(i) activities that address near-term technical problems and permit exploitation of current market opportunities of the wind energy industry;

(ii) developing advanced airfoils and variable speed generators to increase wind turbine output and reduce maintenance costs by decreasing structural stress and fatigue;

(iii) increasing the basic knowledge of aerodynamics, structural dynamics, fatigue and electrical systems interactions as applied to current wind energy technology; and

(iv) improving the compatibility of electricity produced from windfarms with conventional utility needs.

(B) Specific goals for the Wind Energy Research Program shall be to—

(i) reduce average wind energy costs to 3 to 5 cents per kilowatt hour by 1995;

(ii) reduce capital costs of new wind energy systems to $500 to $750 per kilowatt of installed capacity by 1995;

(iii) increase installed wind generating capacity to 4,000 to 8,000 megawatts by 1995;

(iv) reduce operation and maintenance costs for wind energy systems to less than 1.0 cents per kilowatt hour by 2,000; and

(v) increase capacity factors for new wind energy systems to 25 to 30 per centum by 1995.

(2) PHOTOVOLTAICS.—(A) In general, the goals of the Photovoltaic Energy Systems Program include improving the reliability and conversion efficiencies and lowering the costs of photovoltaic conversion. Research efforts shall emphasize

advancements in the performance, stability and durability of photovoltaic materials.

(B) Specific goals of the Photovoltaic Energy Systems Program shall be to—

(i) improve operational reliability of photovoltaic modules to 30 years by 1995;

(ii) increase photovoltaic conversion efficiency of new photovoltaic amorphous silicon modules to 15 per centum by 1995;

(iii) decrease new photovoltaic module direct manufacturing costs to $0.80 per watt by 1995; and

(iv) increase installed capacity of photovoltaic electric power production capacity to 100 to 200 megawatts by 1991.

(3) SOLAR THERMAL.—(A) In general, the goal of the Solar Thermal Energy Systems Program shall be to advance research and development to a point where solar thermal technology is cost-competitive with conventional energy sources and to promote the integration of this technology into the production of industrial process heat and the conventional utility network. Research and development shall emphasize development of a thermal storage technology to provide capacity for shifting power to periods of demand when full insulation is not available, improvement in receivers, energy conversion devices, and innovative concentrators using stretch

membranes, lenses and other materials, as well as exploration of advanced manufacturing techniques.

(B) Specific goals of the Solar Thermal Energy Systems Program shall be to—

(i) reduce solar thermal costs for industrial process heat to $9.00 per million Btu; and

(ii) reduce average solar thermal costs for electricity to 4 to 5 cents per kilowatt hour.

(4) The President's budget request for fiscal year 1989 shall contain the Secretary's recommendations for specific cost, installed capacity and other pertinent goals for 1995 for Department of Energy research and development programs in Biofuels Energy Systems, Solar Buildings Energy Systems, Ocean Energy Systems and Geothermal Energy.

(b) There is authorized to be appropriated to the Secretary—

(1) for the Wind Energy Research Program, an amount not to exceed $19,000,000 in fiscal year 1988; $22,000,000 in fiscal year 1989; and $26,000,000 in fiscal year 1990;

(2) for the Photovoltaic Energy Systems Program, an amount not to exceed $43,100,000 in fiscal year 1988; $45,000,000 in fiscal year 1989; and $50,000,000 in fiscal year 1990;

(3) for the Solar Thermal Energy Systems Program, an amount not to exceed $28,700,000 in fiscal year 1988; $32,000,000 in fiscal year 1989; and $35,000,000 in fiscal year 1990;

(4) for the Biofuels Energy Systems Program, an amount not to exceed $32,100,000 in fiscal year 1988; $35,100,000 in fiscal year 1989; and $40,000,000 in fiscal year 1990;

(5) for the Solar Buildings Energy Systems Program, an amount not to exceed $8,000,000 in fiscal year 1988; $9,000,000 in fiscal year 1989; and $10,000,000 in fiscal year 1990;

(6) for the Ocean Energy Systems Program, an amount not to exceed $5,000,000 in fiscal year 1988; $5,000,000 in fiscal year 1989; and $5,000,000 in fiscal year 1990;

(7) for the Geothermal Program, an amount not to exceed $34,900,000 in fiscal year 1988; $38,700,000 in fiscal year 1989; and $35,700,000 in fiscal year 1990.

(c)(1)(A) The President's budget request for fiscal year 1990 shall include the Secretary's recommendations for at least one proposed proof-of-concept or near-commercial demonstration project in each of the categories represented by paragraphs (1), (2) and (3) of subsection (b). Each proposed

project shall be described in sufficient detail to support congressional authorization and solicitation of bids for construction of necessary facilities.

(B) A list and description of alternative project plans recommended by the Secretary under this paragraph shall be submitted in President's fiscal year 1989 budget request. Such plans shall require funding or in-kind contributions from private sources in support of up to 50 per centum of total project costs.

(C) In selecting projects under this paragraph, the Secretary shall take into account the extent to which such projects will contribute to earlier commercialization of key technologies within such categories than might occur without Federal support under this paragraph and the extent to which such projects will contribute to the competitiveness of United States firms engaged in international trade in renewable energy technologies.

(2) On or before May 1, 1989, the Secretary shall submit to Congress a report analysing options available to the Secretary under existing law to accelerate the timely commercialization of wind, photovoltaic, solar thermal, biofuels, biomass, solar buildings, ocean and geothermal renewable energy technologies through emphasis on development and demonstration assistance to specific technologies in the

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research, development and demonstration programs of the Department of Energy that are near commercial application.

(3) Whenever the Secretary determines that any of the goals established under this section is no longer appropriate, he shall notify Congress of the reason for the determination and provide an amended goal that is consistent with the purposes of this Act.

SEC. 5. ENERGY CONSERVATION RESEARCH AND DEVELOPMENT.

(a) The President's budget request for fiscal years 1989 and 1990 shall include the Secretary's recommendations of amounts to be set aside for new initiatives in energy conservation research and development. Funds made available for new initiatives shall supplement and not supplant funds available to complete on-going energy conservation research and development projects supported in whole or in part by the Secretary during fiscal year 1988. Funds made available for new initiatives shall be used by the Secretary to support the most promising and deserving new ideas in energy conservation research and development brought to the attention of the Secretary during the previous fiscal year.

(b)(1) There is hereby authorized to be appropriated to the Secretary for the energy conservation research and development programs of the Secretary, an amount not to exceed $187,137,000 in fiscal year 1988, of which

$20,250,000 shall be available for new initiatives, as set forth below:

(A) for transportation energy conservation research and development, there is authorized to be appropriated to the Secretary an amount not to exceed $58,200,000, of which $3,200,000 shall be made available for new initiatives;

(B) for industrial energy conservation research and development, there is authorized to be appropriated to the Secretary an amount not to exceed $42,300,000, of which $5,800,000 shall be available for new initiatives;

(C) for buildings and community systems energy conservation research and development, there is authorized to be appropriated to the Secretary an amount not to exceed $51,975,000, of which $9,250,000 shall be available for new initiatives;

(D) for multi-sector energy conservation research and development, there is authorized to be appropriated to the Secretary an amount not to exceed $33,000,000, of which $2,000,000 shall be available for new initiatives; and

(E) for energy conservation research and development policy and management, there is authorized to be

appropriated to the Secretary an amount not to exceed $1,662,000.

(2) There is hereby authorized to be appropriated to the Secretary for the energy conservation research and development programs of the Secretary, an amount not to exceed $201,403,000 in fiscal year 1989, of which $6,000,000 shall be available for new initiatives, as set forth below:

(A) for transportation energy conservation research and development, there is authorized to be appropriated to the Secretary an amount not to exceed $63,200,000, of which $2,000,000 shall be made available for new initiatives;

(B) for industrial energy conservation research and development, there is authorized to be appropriated to the Secretary an amount not to exceed $45,000,000, of which $1,000,000 shall be available for new initiatives;

(C) for buildings and community systems energy conservation research and development, there is authorized to be appropriated to the Secretary an amount not to exceed $55,775,000, of which $2,000,000 shall be available for new initiatives;

(D) for multisector energy conservation research and development, there is authorized to be appropriated to the Secretary an amount not to exceed

$35,700,000, of which $1,000,000 shall be available for new initiatives; and

(E) for energy conservation research and development policy and management, there is authorized to be appropriated to the Secretary an amount not to exceed $1,728,000.

(3) There is hereby authorized to be appropriated to the Secretary for the energy conservation research and development programs of the Secretary, an amount not to exceed $209,147,000 in fiscal year 1990, of which $6,000,000 shall be available for new initiatives, as set forth below:

(A) for transportation energy conservation research and development, there is authorized to be appropriated to the Secretary an amount not to exceed $65,460,000, of which $2,000,000 shall be made available for new initiatives;

(B) for industrial energy conservation research and development, there is authorized to be appropriated to the Secretary an amount not to exceed $46,740,000, of which $1,000,000 shall be available for new initiatives;

(C) for buildings and community systems energy conservation research and development, there is authorized to be appropriated to the Secretary an amount

not to exceed $58,100,000, of which $2,000,000 shall be available for new initiatives;

(D) for multisector energy conservation research and development, there is authorized to be appropriated to the Secretary an amount not to exceed $37,050,000, of which $1,000,000 shall be available for new initiatives; and

(E) for energy conservation research and development policy and management, there is authorized to be appropriated to the Secretary an amount not to exceed $1,797,000.

SEC. 6. JOINT RESEARCH AND DEVELOPMENT VENTURES.

(a)(1) Congress finds that joint research and development ventures can—

(A) improve coordination in technology development among firms in industries attempting to commercialize renewable energy and energy conservation technologies;

(B) assist in setting national standards to improve the operation of markets for these technologies; and

(C) enhance the ability of domestic firms to compete with foreign enterprises in sales of renewable energy and energy conservation technologies.

(2) The purpose of this section is to direct the Secretary of Energy to make use of joint research and development

ventures to further commercialization of renewable energy and energy conservation technologies.

(3) As used in this section the term "joint research and development venture" means a joint research and development venture under the National Cooperative Research Act of 1984 (98 Stat. 1815).

(b)(1) The Secretary shall establish seven joint research and development ventures in accordance with the provisions of this section. Each joint research and development venture under this section shall include manufacturing firms, investors, an advisory committee appointed in accordance with this section and such other participation as the Secretary deems appropriate to achieve the purposes of this section.

(2) The Secretary shall establish at least one joint research and development venture in accordance with subsection (c) to develop technology and expertise for domestic commercial use and for export in—

(A) photovoltaics technology;

(B) wind energy technology;

(C) solar thermal technology;

(D) factory-made housing;

(E) advanced district cooling technology;

(F) integrated renewable energy systems; and

(G) renewable energy and energy conservation technology exports.

(3) Not later than one hundred and eighty days after the date of the enactment of this section the Secretary shall publish plans to implement this section and report to Congress on such plans.

(c) Joint Research and Development Ventures.

PHOTOVOLTAICS TECHNOLOGY

(1)(A) The Secretary shall establish and provide financial assistance to a joint research and development venture for the development of high-efficiency thermal and electrical distribution, storage and end-use systems employing electricity from photovoltaic conversion of solar energy that may be deployed in villages in remote or rural areas, including villages in developing countries.

(B) The purpose of the venture under subparagraph (A) shall be to design, test and demonstrate an integrated, cost-efficient village energy system including components for electrical and thermal production, conversion, distribution, storage and use under electronic control.

(C) Subsystems of the village energy system under this paragraph may include—

(i) advanced photovoltaic concentrators or other photovoltaic arrays;

(ii) an electronically-controlled village electrical system;

(iii) a potable water desalination system employing multistage flash distillation technology; and

(iv) a small scale village refrigeration system employing a low-temperature chiller driven by waste heat from the village energy system or by photovoltaic arrays.

(D) The Secretary shall appoint members to an Advisory Committee on Photovoltaic Village Energy Systems to assist the Secretary in carrying out his responsibilities with respect to the joint venture under this paragraph. Such committee shall include at least one member representing—

(i) firms in the photovoltaic manufacturing industry;

(ii) the Secretary of Commerce;

(iii) the Director of the Agency for International Development;

(iv) the Director of the Export-Import Bank;

(v) the Electric Power Research Institute;

(vi) the Solar Energy Research Institute; and

(vii) such other groups or institutions as the Secretary deems appropriate.

(E) There is authorized to be appropriated to the Secretary a total of not more than $1,200,000 for fiscal years 1988, 1989 and 1990 to carry out the purposes of this paragraph.

WIND ENERGY TECHNOLOGY

(2)(A) The Secretary shall establish and provide financial assistance to a joint research and development venture

for the development of high-efficiency thermal and electrical distribution, storage and end-use systems employing wind-diesel systems designed for use where diesel generation of electricity currently is being used at a site with significant wind energy potential.

(B) The purpose of the venture under subparagraph (A) shall be to design, test and demonstrate an integrated, cost-efficient wind-diesel village energy system including components for electrical and thermal production, conversion, distribution, storage and use under electronic control.

(C) Subsystems of the village energy system under this paragraph may include—

(i) a diesel generator operating in conjunction with one or more wind turbines;

(ii) an electronically-controlled village electrical system;

(iii) a potable water desalination system employing multistage flash distillation technology; and

(iv) a small scale village refrigeration system employing a low-temperature chiller driven by excess wind-generated energy or a combination of wind-generated and diesel-generated energy.

(D) The Secretary shall appoint members to an Advisory Committee on Wind Energy Village Energy Systems to assist the Secretary in carrying out his responsibilities with

respect to the joint venture under this paragraph. Such committee shall include at least one member representing—

(i) firms in the wind energy equipment manufacturing industry;

(ii) the Secretary of Commerce;

(iii) the Director of the Agency for International Development; and

(iv) the Director of the Export-Import Bank;

(v) the Electric Power Research Institute;

(vi) the Solar Energy Research Institute; and

(vii) such other groups or institutions as the Secretary deems appropriate.

(E) There is authorized to be appropriated to the Secretary a total of not more than $1,200,000 for fiscal years 1988, 1989 and 1990 to carry out the purposes of this paragraph.

SOLAR THERMAL TECHNOLOGY

(3)(A) The Secretary shall establish and provide financial assistance to a joint research and development venture for the efficient use of solar thermal energy deployed in planned communities in the United States and overseas as a total energy system for the supply of electricity, industrial energy, potable water, refrigeration and the community heating and cooling needs, and the treatment of community-generated wastes.

(B) The purpose of the venture under paragraph (A) shall be to design, test and demonstrate an integrated, cost-effective community total energy system including components for thermal production, conversion, distribution, storage and use under automated control.

(C) Subsystems of the community total energy system under this paragraph may include:—

(i) advanced solar thermal concentrators;

(ii) a potable water desalination system employing advanced thermal distillation technology;

(iii) an automated energy distribution and control system;

(iv) a thermally-driven solar refrigeration system; and

(v) advanced waste treatment systems using thermal energy or direct concentrated solar flux.

(D) The Secretary shall appoint members to an Advisory Committee on Solar Thermal Community Total Energy Systems to assist the Secretary in carrying out his responsibilities with respect to the joint venture under this paragraph. Such committee shall include at least one member representing—

(i) firms in the solar thermal manufacturing industry;

(ii) the Secretary of Commerce;

(iii) the Director of the Agency for International Development;

(iv) the Director of the Export-Import Bank;

(v) the Electric Power Research Institute;

(vi) the Gas Research Institute;

(vii) the Solar Energy Research Institute; and

(viii) such other groups or institutions as the Secretary deems appropriate.

(E) There is authorized to be appropriated to the Secretary a total of not more than $900,000 annually for fiscal years 1988 through 1992 to carry out the purposes of this paragraph.

FACTORY-MADE HOUSING

(4)(A) Congress finds that—

(i) the United States is moving toward the industrialization of home building;

(ii) ninety per centum of new homes have factory-made components and over four hundred thousand of the approximately two million homes built each year are largely factory-made;

(iii) the United States is facing competition from foreign home builders who make use of factory-made housing techniques;

(iv) foreign firms have begun to penetrate United States markets for homes and housing-related products,

while United States exports in these categories have stagnated;

(v) housing construction and materials comprises 21 per centum of the Gross National Product;

(vi) the Office of Technology Assessment has found that the technological innovations that could improve the quality and reduce the cost of housing in the United States are "being needlessly slowed by inadequate research and development";

(vii) the Department of Commerce has warned that foreign competitors have targeted the United States market for residential construction in the same way that domestic markets for autos and steel have been targeted in the past; and

(viii) a joint research and development venture supported in part by the Federal Government is needed to assist the United States home building industry in competing with housing products and technology from overseas.

(B) The Secretary shall establish and provide financial assistance to a joint research and development venture with such specialized private firms and investors as the Secretary deems appropriate in order to establish at least three regional centers to develop techniques to improve the energy performance of factory-made housing offered by United States firms.

In locating the regional centers under this paragraph, the Secretary shall consider regional differences in housing needs, housing design, construction technique, marketing practices and construction materials.

(C) The regional centers under this paragraph shall carry out research and development efforts to improve the quality, energy efficiency and adaptability to renewable forms of energy of factory-made housing offered for sale in the United States and the productivity and energy efficiency of the housing construction process. The research and development programs at these centers shall consider housing design, fabrication, delivery systems, construction processes, marketing and product export.

(D) The research and development strategy under this paragraph shall be guided by—

(i) a detailed characterization of the needs of the home building industry;

(ii) a close working relationship with all sectors of the home building industry; and

(iii) coordination among the centers to pool and conserve resources.

(E) The Secretary shall appoint members to an Advisory Committee on Energy Performance in Factory-Made Housing to assist the Secretary in carrying out his responsibilities with respect to the joint research and development

venture established under this paragraph. Such committee shall include at least one member representing—

(i) the Secretary of Housing and Urban Development;

(ii) the Secretary of Commerce;

(iii) the National Institute of Building Sciences;

(iv) the National Association of Home Builders;

(v) the National Laboratories of the Department of Energy;

(vi) the National Bureau of Standards; and

(vii) such other groups or institutions as the Secretary deems appropriate.

(F) There is authorized to be appropriated to the Secretary a total of not more than $10,000,000 for fiscal years 1988 through 1993 to carry out the purposes of this paragraph.

ADVANCED DISTRICT COOLING TECHNOLOGY

(5)(A) The Secretary shall establish and provide financial assistance to a joint research and development venture with such specialized private firms and investors as the Secretary deems appropriate in order to develop advanced district cooling technologies that are applicable in cities with high cooling loads.

(B) The joint research and development venture under this paragraph shall—

(i) develop technical strategies for decreasing the capital cost and increasing the energy efficiency of major district heating and cooling system components;

(ii) encourage the use of cogeneration and renewable energy technologies in district heating and cooling; and

(iii) assist in transfer of district heating and cooling technology to local governments.

(C) The Secretary shall select three major cities for application of advanced district cooling technologies developed by the joint venture under this paragraph. The activities to be carried out in such application shall include district cooling assessment, feasibility, and engineering design studies.

(D) The Secretary shall appoint members to an Advisory Committee on Advanced District Cooling Technology to assist the Secretary in carrying out his responsibilities with respect to the joint research and development venture under this paragraph. Such Committee shall include at least one member representing—

(i) the Secretary of Housing and Urban Development;

(ii) the Secretary of Commerce;

(iii) firms manufacturing district cooling equipment;

(iv) the National League of Cities; and

(v) such other groups or institutions as the Secretary deems appropriate.

(E) There is authorized to be appropriated for each of the fiscal years 1988 through 1992 not more than $1,000,000 per year to carry out the purposes of this paragraph.

INTEGRATED RENEWABLE ENERGY SYSTEMS

(6)(A) Congress finds that—

(i) the fuel cell is an energy technology that will require Federal assistance to achieve commercial acceptance in domestic and foreign markets;

(ii) use of low maintenance, high efficiency fuel cells can minimize costs, conserve energy and provide opportunities to more fully utilize locally available energy resources;

(iii) fuel cells are self contained, environmentally safe and can provide sufficient energy to operate vehicles, heat, light and cool individual buildings and isolated military, commercial and industrial facilities and function as mobile power sources; and

(iv) integrated energy systems involving fuel cells could provide opportunities for export of fuels cell and renewable energy technology developed in the United States.

(B)(i) The Secretary shall establish and provide financial assistance to a joint research and development venture with

such specialized private firms and investors as the Secretary determines appropriate in order to address the problems of variable output from solar and wind energy systems. The primary emphasis of the joint research and development venture under this paragraph shall be the integration of solar and wind energy systems with fuel cell and energy storage systems so as to produce approximately constant output.

(ii) Such joint venture shall emphasize the production of reliable electric power capable of meeting utility requirements, but may also consider single purpose needs such as portable medical uses, vehicular applications and the provision of heat, light and cooling in isolated areas at efficiency and cost improvements over central utility service.

(C) The joint research and development venture under this paragraph shall consider the interests of electric and natural gas utilities and manufacturers of fuel cells and renewable energy systems in order to enhance the ability of solar and wind energy to contribute to the demand for electric power in the 1990's.

(D) The Secretary shall appoint members to an Advisory Committee on Integrated Renewable Energy Systems to assist the Secretary in carrying out his responsibilities with respect to the joint research and development venture under this paragraph. Such committee shall include at least one member representing—

(i) firms manufacturing solar, wind or fuel cell equipment;

(ii) the Secretary of Commerce;

(iii) the Director of the Agency for International Development;

(iv) the Director of the Export-Import Bank;

(v) the Solar Energy Research Institute;

(vi) the Electric Power Research Institute;

(vii) the Gas Research Institute; and

(viii) such other groups or institutions as the Secretary deems appropriate.

(E) There is authorized to be appropriated to the Secretary in total for the fiscal years 1988 through 1993 an amount not to exceed $5,000,000 to carry out the purposes of this paragraph.

EXPORT TECHNOLOGY PROJECTS

(7)(A) Congress finds that—

(i) the United States has several advanced energy conservation and renewable energy technologies that lack only sufficient coordination, support, and emphasis to become important export items capable of reducing the United States' trade deficit;

(ii) a major barrier to export of energy conservation and renewable energy technology is the lack of information on overseas markets and technology development by foreign competitors;

(iii) the industry that markets energy conservation technology is highly fragmented and the renewable energy industry is comprised of small firms that lack the necessary resources to identify and target overseas markets;

(iv) a joint research and development venture is needed to bring together a broad array of manufacturing firms, financial institutions, and Federal agencies to identify and develop promising technologies and export markets for energy conservation and renewable energy technologies.

(B) The Secretary shall establish and provide financial assistance to a joint research and development venture with such specialized private firms and investors as the Secretary determines appropriate for the purpose of improving energy conservation and renewable energy manufacturing processes in order to enhance product reliability and cost competitiveness relative to foreign-made products. The joint venture under this paragraph shall be coordinated with research, assessment and targeting of foreign markets for energy conservation and renewable energy products.

(C) The Secretary shall appoint members to an Advisory Committee on Energy Conservation and Renewable Energy Technology Exports to assist the Secretary in carrying out his responsibilities with respect to the joint research and de-

velopment venture under this paragraph. Such committee shall include at least one member representing—

(i) the Secretary of Commerce;

(ii) the Director of the Agency for International Development;

(iii) the Director of the Export-Import Bank;

(iv) the United States Export Council for Renewable Energy;

(v) the National laboratories for the Department of Energy; and

(vi) such other groups or institutions as the Secretary deems appropriate.

(D) There is authorized to be appropriated to the Secretary to carry out the purposes of this paragraph a total amount for fiscal years 1988 through 1993 not to exceed $5,000,000 with respect to renewable energy activities under this paragraph and $5,000,000 with respect to energy conservation activities under this paragraph.

SEC. 7. RENEWABLE ENERGY AND ENERGY CONSERVATION IN FEDERAL BUILDINGS.

(a)(1) Congress finds that—

(A) the Federal Government consumes large amounts of energy at significant cost to heat and cool buildings owned or leased by Federal agencies;

(B) the potential for savings in energy and in budget outlays in Federal buildings is large and should be brought to the attention of heads of the Federal agencies responsible for such buildings; and

(C) the Secretary of Energy should make use of expertise in energy conservation and the use of renewable energy already in existence in the Federal establishment to assess systematically the potential for budget savings in Federal buildings.

(2) The purpose of this section is to require the Secretary of Energy to analyze the potential for improved energy efficiency and for use of renewable forms of energy in a limited but representative sample of Federal buildings and to make recommendations for energy conservation and renewable energy improvements in such buildings.

(3) As used in this section, the term "Federal building" has the meaning given such term in section 521 of the National Energy Conservation Policy Act and includes facilities used in connection with such Federal building.

(b)(1) The Secretary shall establish a Federal Energy Analysis Team to analyze, and make recommendations with respect to energy conservation and the use of renewable energy in, specific Federal buildings selected by the Secretary under this section. The Team shall be made up of individuals—

(A) engaged in research on energy conservation or the use of renewable energy in buildings at the National Laboratories of the Department of Energy; and

(B) nominated by the Secretary of Defense, the Administrator of the General Services Administration and the Director of the National Bureau of Standards, respectively, on the basis of their expertise in energy conservation and the use of renewable forms of energy in buildings.

Persons who serve on the Team shall be transferred to the Team for purposes of this section without loss of salary or benefits.

(2) The Team shall conduct an analysis of energy use in Federal buildings designated by the Secretary under paragraph (3) to determine the potential for the use of renewable forms of energy and for improved energy conservation in such buildings and make recommendations for cost-effective renewable energy and energy conservation improvements in such buildings. For purposes of this section an improvement shall be considered cost effective if cost of the energy saved or displaced by the improvement exceeds the cost of the improvement over the life or remaining term of lease of the building.

(3) The Secretary shall designate buildings to be analyzed by the Team so as to obtain a sample of buildings of the

types and in the climates that is representative of the Federal buildings owned or leased by Federal agencies in the United States that consume the major fraction of the energy consumed in Federal buildings.

(4) The Secretary shall submit a plan for implementing this subsection to Congress within six months after the date of the enactment of this section.

(5) The Team shall report its findings and recommendations based on the analyses carried out under paragraph (2) to the Secretary and to the head of the agency owning or leasing each building analyzed within eighteen months after the date of the enactment of this section.

(b)(1) The Secretary shall use the results of the analyses under subsection (a) to develop goals for 1995 for energy conservation and the use of renewable energy in Federal buildings generally and in the categories identified by the Secretary under subsection (a)(3). Goals developed under this subsection shall be submitted to Congress within twenty four months after the date of the enactment of this section.

(2) Any agency that chooses not to implement promptly the recommendations of the Team with respect to a Federal building analyzed under subsection (a)(2) shall provide Congress with a written explanation of the reasons for such choice.

(3) Any agency that implements the recommendations of the Team with respect to a Federal building analyzed under subsection (a)(2) may retain for purposes of furthering the objectives of the agency one half of the dollar savings realized as a result of such recommendations. The Secretary shall consult with the heads of appropriate Federal agencies to insure that the maximum dollar savings under this subsection are realized.

(c) There is hereby authorized to be appropriated to the Secretary for purposes of carrying out this section $250,000.

SEC. 8. RENEWABLE ENERGY EXPORTS.

(a)(1) Congress finds that—

(A) Among the major problems in promoting exports of renewable energy technology are the lack of available information on overseas markets and the absence of financing for the purchase of the technologies; and

(B) the Committee on Renewable Energy, Commerce, and Trade established under the Renewable Energy Industry Development Act (Public Law 98–370) currently coordinates Federal Government activities to promote renewable energy exports.

(2) The purpose of this section is to evaluate current efforts to promote exports of renewable energy technology, to establish a joint government-industry plan to identify promis-

ing technologies and increase the financing available for exports of renewable energy technologies, to target potential markets for these technologies and to authorize funding of these activities.

(b) In order to provide reliable information on overseas markets for renewable energy technology, the Secretary shall review the activities of the Committee on Renewable Energy, Commerce, and Trade in order to determine if current efforts by such Committee to promote exports of renewable energy technology are sufficient and whether additional efforts are necessary. The Secretary shall report to Congress the results of such review on or before six months after the date of the enactment of this section.

(c) Each participating member of the Committee on Renewable Energy, Commerce, and Trade shall report annually to Congress on the actions of such agency during the previous fiscal year to achieve the purposes of the Committee on Renewable Energy, Commerce and Trade and of this section. Such report shall describe the exports of renewable energy technology that have occurred as a result of such agency actions.

(d) The Committee on Renewable Energy, Commerce, and Trade shall—

(1) establish a joint government-industry plan to maintain or increase the market share of the United

States in international trade in renewable energy technologies, including technologies for production of alcohol fuels, biomass energy, geothermal energy, wood energy, and in technologies for passive solar energy conversion, photovoltaics, solar thermal energy conversion and wind energy conversion. Such plan shall include guidelines for agencies that are members of the Committee with respect to the financing of exports of such renewable energy technologies.

(2) develop, in consultation with representatives of affected industries, administrative guidelines for Federal export loan programs to simplify application by firms seeking export assistance for renewable energy technologies from agencies implementing such programs; and

(3) target renewable energy technology markets for primary emphasis by Federal export loan programs, development programs and private sector assistance programs.

(e) There is hereby authorized to be appropriated to the Secretary for activities of the Committee on Renewable Energy, Commerce, and Trade an amount not to exceed—

(1) $1,500,000 in fiscal year 1988;

(2) $2,200,000 in fiscal year 1989 and;

(3) $2,500,000 in fiscal year 1990.

SEC. 9. REPORTS.

(a) One year after the date of the enactment of this Act and annually thereafter the Secretary shall report to Congress on the programs, projects and ventures conducted under this Act and the progress being made towards accomplishing the goals and purposes set forth in this Act, including the goals set forth in section 4.

(b) Each annual submission of the National Energy Policy Plan under title VIII of Public Law 95–91 shall be accompanied by a three-year strategic plan for energy technology research, development and demonstration. Such plan shall address the role of federally-assisted research, development and demonstration in the achievement of the national policy goals of the National Energy Policy Plan and shall assess both the level of support for energy research, development and demonstration reasonably necessary to achieve these goals and the basis for allocating the support recommended by the President among the available alternatives. At a minimum, these alternatives shall include energy conservation and renewable energy technologies.

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STATEMENT OF HON. SPARK M. MATSUNAGA, A U.S. SENATOR FROM THE STATE OF HAWAII

Senator MATSUNAGA. Thank you very much, Mr. Chairman. I thank you for the courtesy extended to me to speak in support of two bills before this committee. One is S. 1554, Renewable Energy and Energy Conservation Technology Competitiveness Act of 1987, introduced by Senator Fowler of your committee. The other is S. 1320, a bill to provide adequate funding levels for solar energy research and development, introduced by Senator Bumpers, also a member of your committee.

As a former member of the Energy and Natural Resources Committee, I am most pleased to be an original co-sponsor of these two most important pieces of legislation.

As I mentioned on the Senate Floor last week in a colloquy with the junior Senator from Georgia, Mr. Fowler, it is my firm conviction that unless we establish ourselves as an energy self-sufficient nation, we shall not be able fully and effectively to control our own economic destiny.

This imperative in turn requires us to exploit our renewable energy resources and to broaden the mix of these sources that we employ in our industries, in our commerce and transportation, and in our households.

But we are not making much progress toward this imperative. On the contrary. According to the recently issued report on the nation's energy security issued by the Department of Energy, within a mere two years we have increased our reliance on imported crude oil from 27 percent to 38 percent, which is three percent higher than the 1973 figure in effect at the time of the OPEC embargo. In this light, the present Administration's lack of support for renewable energy development is inexplicable to me.

Furthermore, renewable energy is another area where American technology is being seized upon, advanced, and perfected overseas in such fields as wind machines and hydrogen production, for example. Even fuel cells, a technology flowing from our own space program, is pioneering applications overseas. I have two bills on this subject, Mr. Chairman, together with one on hydrogen R&D, which I look forward to discussing with your subcommittee next month.

For these reasons, if not for any other, both of these bills deserve the support of the committee. The Fowler bill, S. 1554, addresses the overseas competitiveness concerns. It recognizes that American competitiveness overseas depends in large part on long-term stable Federal support of research and development efforts to maintain U.S. preeminence in technology, notably renewable energy technology. The present administration's policy of encouraging only long range basic energy research has not advanced new energy technologies to the point where industry is in a position to capitalize on the findings of Federal research. The demonstration projects called for in S. 1554 should go a long way toward redressing this situation. In fact, the bill should reinvigorate the DOE conservation and energy program.

Similarly, the Bumpers bill, S. 1320, provides essential planning continuity for solar R&D programs by legislating 3-year term mini-

mum authorization levels. It also mandates the energy secretary to expedite near-term commercial applications in the solar field, as well as to continue the current emphasis on long-term research.

The Bumpers bill would spur the Federal solar buildings demonstration program, and, in my view, provide critically needed reaffirmation of Congressional support for renewable energy in international trade. The section of the bill on Federal procurement incentives for solar energy reflects only prudent measures if the Federal Government is to maximize its investments to date in solar technologies. The same can be said for the section on existing Federal loan programs for small business and exports.

An excellent feature of this legislation is that it institutes a renewable energy self-sufficiency carrot to the countries under the Caribbean Basin Initiative.

In summary, Mr. Chairman, members of the committee, both bills are very much in the national interest at this time, and I urge all members of the committee to support their early approval.

I thank you, Mr. Chairman.

Senator FORD. Thank you, Senator. I have no questions. Senator Fowler, do you have any questions of him?

Senator FOWLER. I have no questions, but just want to thank the Senator from Hawaii again for his long time advocacy.

Senator FORD. I still have a flashlight in my office that he gave me in my office in 1979, and the darn thing still works from some kind of ocean-generated power. Otec—is that it? Mini Otec. Well, it's been a while since we were there, but the flashlight still works. I wanted to compliment you on that. When the juice runs out I want you to take it out and get it refueled for me again. Will you? [Laughter.]

Thank you, my friend.

Senator MATSUNAGA. Thank you.

Senator FORD. We now have in our attendance Senator Hecht from Nevada. Do you have any opening statement, Senator?

OPENING STATEMENT OF HON. CHIC HECHT, A U.S. SENATOR FROM THE STATE OF NEVADA

Senator HECHT. Thank you. Just to let you know, Mr. Chairman, these two bills are very important for my State since we have an abundance of sunshine. We hope we'll be able to use that for energy.

[The prepared statement of Senator Hecht follows:]

STATEMENT OF SENATOR HECHT

Mr. Chairman, I want to thank you for holding this hearing today on renewable energy. One of the great longterm problems facing this country is the lack of a comprehensive national energy policy.

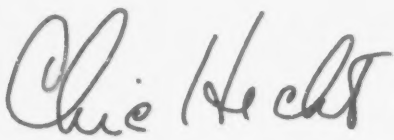
This nation definitely needs to do all it can to encourage renewable energy. While these forms of energy currently contribute a relatively small amount to the total national energy supply, they have very significant potential.

Solar energy, used for heating as well as for electricity, is one of the more commonly known forms of renewable energy. Hydroelectric energy has been with us for quite a few years, and has contributed significantly to the development of my part of the country. With the exception of hydroelectric power, geothermal energy is the single greatest renewable source of energy. I have been a strong proponent of encouraging further geothermal development in this country. In my own state, Nevada, it has been estimated that the geothermal potential is equal to the energy of four large nuclear power plants.

Already, geothermal power provides most of the electric needs of the city of San Francisco, and other geothermal projects are contributing to the power supply of southern California, as well.

Solar, geothermal, biomass, wind, and other more exotic forms of renewable energy will be increasing important to our country in the years ahead. We need to lay the groundwork now so that these technologies will be there when we need to draw on them. and we must encourage American firms that are involved in this industry, so that we do not later have to buy these technologies from abroad.

Thank you, Mr. Chairman. I look forward to today's hearing.



Senator FORD. Thank you, Senator.

The first witness will be the Honorable William Martin, Deputy Secretary, U.S. Department of Energy. He will be accompanied by the Honorable Donna Fitzpatrick, Assistant Secretary, Office of Conservation and Renewable Energy.

We're delighted to see you all. This is the young man that came here with energy and vigor, and he's been worn down a little bit since he arrived. Remember that time when you were coming across the table at us in here? You don't remember that, do you?

That's like trying to remember how to mix a Poindexter cocktail: I forgot.

STATEMENT OF WILLIAM F. MARTIN, DEPUTY SECRETARY, DEPARTMENT OF ENERGY, ACCOMPANIED BY DONNA R. FITZPATRICK, ASSISTANT SECRETARY, OFFICE OF CONSERVATION AND RENEWABLE ENERGY, DEPARTMENT OF ENERGY

Senator FOWLER. Go ahead, Mr. Secretary. We welcome you.

Mr. MARTIN. Thank you, Senator Fowler, Mr. Chairman, Senator Hecht.

We are happy to be here today because I think the issue of energy is getting a lot more attention, as it should. As you're well aware, we produced a report on energy security in March for the President. It clearly showed that if low oil prices persist, this country will become very dependent on imported oil, maybe more than 50 percent, maybe as much as eight to ten million barrels a day by 1995.

We share a great concern about energy security, as so well stated by Senator Fowler. Let me say that in the short term we see our greatest vulnerability being oil. That is why we need to have a viable oil and gas industry in this country.

But over the longer term we really see two important strategies. One is to develop alternative fuels for transport because, indeed, the energy security issue really is oil, and oil is used in transport. We're taking a real hard look at ethanol and methanol, the distribution system, the economics and the technology. That's very important and we are doing that, with a report due by the end of next year.

At the same time we think we need to look hard at electrification. There we have nuclear, clean coal, and the important role of renewables. I think that is what I will focus my remarks on today. Where do we see renewables going?

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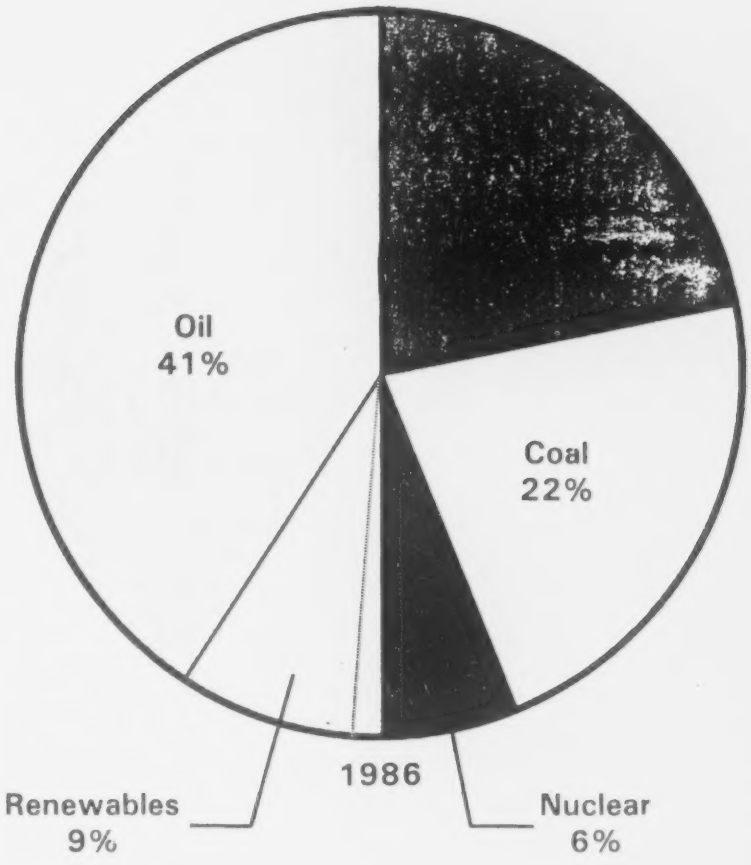
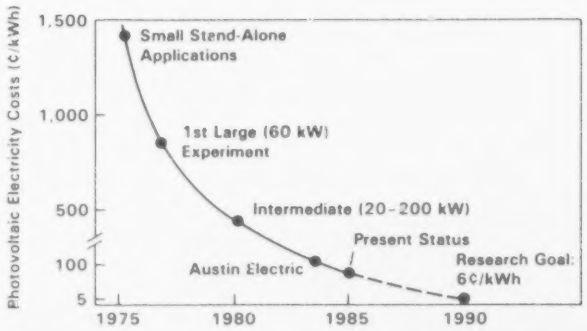
RENEWABLES PROVIDE A SIGNIFICANT SHARE OF TOTAL U.S. ENERGY CONSUMPTION



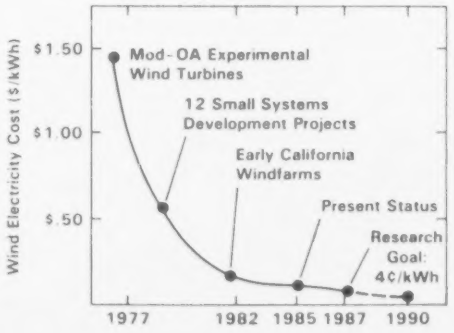
The first chart shows that today renewables are about 9 percent of our energy. That is a little misleading. Most of that is hydro and biomass. What we would think of as solar, geothermal, and wind, is really less than one percent at this time.

But let me say, while that 1 percent is small, it has come a long way from the mid-1970's. Recently Frank Potter, whom you will hear from today, hosted a meeting of the Renewable Energy Institute where we took a morning to get the view of experts on how far certain technologies have come in the last year with the support and R&D of the Nation and efforts by the private sector.

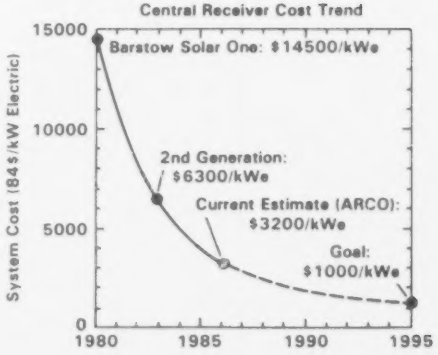
PROGRESS TOWARD COMPETITIVENESS
PHOTOVOLTAICS



WIND



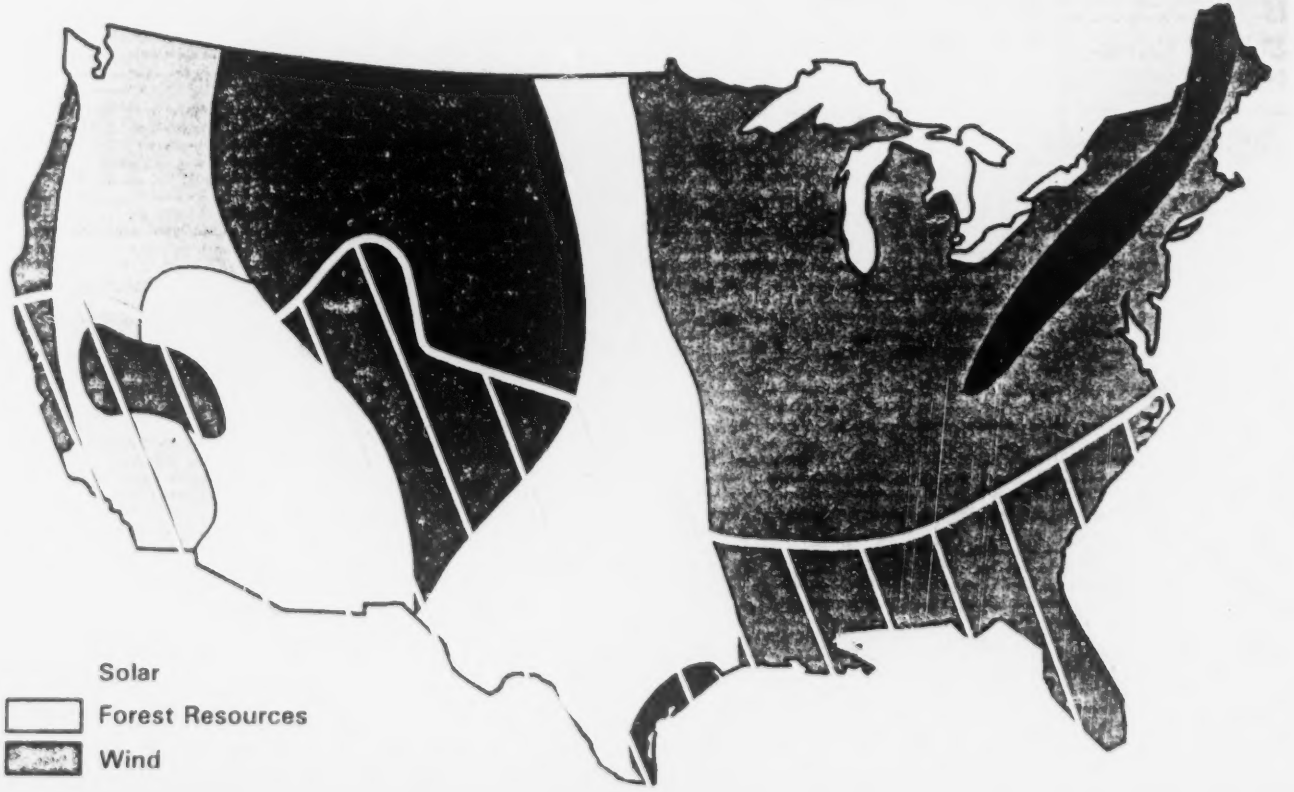
SOLAR THERMAL



Quite frankly, the record is very impressive. For example, as the next chart shows, photovoltaics have seen a one-hundred-fold decrease in the cost. Wind power has seen a ten-fold decrease in cost. In the case of solar collectors, a 35 percent decrease in cost.

I think this progress that we've seen is due, in large part, to wise and prudent use of our resources. Let me say that it's very important when you're thinking about renewables to think about how you use them, how they meet energy demands, and what are the advantages of different parts of our country.

RENEWABLE ENERGY RESOURCE BASE



The last visual I want to show is a kind of cool and calming blue and green visual for the summer. But it demonstrates that this Nation has considerable resource bases for renewable energy. Solar and wind can be used in almost all areas of the country. In fact, today 40 electrical utilities use photovoltaics. California, Nevada, and the Gulf Coast have potentially significant geothermal resources. In fact, the largest geothermal facility in the world is in northern California. It produces the equivalent of 50,000 barrels of oil a day.

Forest products are particularly useful in the paper industry in New England. Biomass is increasingly important. Recently, Senator Fowler, I visited the biomass facility in Savannah. I was very impressed. Each of us produces a ton of garbage each year. Here is a facility which takes the waste of Savannah and produces power. It solves your landfill problem and it helps you with your energy situation.

Let me also say I took an opportunity to visit your solar facility in the Shenandoah. Again, a very impressive demonstration project. I talked with Ernie Nye there, who I know has testified before at hearings you have had. Ernie made one point to me that I think in a way represents our philosophy toward renewables.

That is, put your money in research and development. Don't put your money into demonstration. That is really one of the themes that we want to stress here today and talk about. Let me also say that one of our goals is to advance the technology base while letting industry develop specific applications—products and services.

Let me tell you right now, I know that many industries which have evolved, based on renewable energy resources, are in as tough shape as the oil industry or the gas industry or the coal industry in this country. They do face problems. We have some sympathy for them, as we do for all of our energy industries at this troubled time. So it's not that we're not recognizing that these industries are having problems. We still think the wisest use of our limited funds is really to put it into basic R&D.

We also say that we're promoting markets and products to the Committee on Renewable Energy Commerce and Trade. We're also seeking to improve international competitiveness. To this extent, Secretary Herrington a couple of weeks ago announced a series of industrial forums to facilitate our international and domestic research agenda. He also announced a new award for renewable energies, the John Ericsson award.

Mr. Chairman, I do appreciate the opportunity to talk with you. We've talked a lot together about oil, gas and coal. I think it's a good time to talk about the future of renewables.

Thank you very much.

[The prepared statement of Mr. Martin follows:]

STATEMENT OF

WILLIAM F. MARTIN

DEPUTY SECRETARY

U.S. DEPARTMENT OF ENERGY

BEFORE THE

SUBCOMMITTEE ON ENERGY RESEARCH AND DEVELOPMENT

OF THE

COMMITTEE ON ENERGY AND NATURAL RESOURCES

U.S. SENATE

AUGUST 6, 1987

Mr. Chairman and Distinguished Members of the Committee:

It is a pleasure to be here with you today to discuss renewable energy and ways to insure that renewable energy plays an effective role in our energy future.

Energy Security Concerns

Concern for our Nation's energy security is on the rise as the world oil situation is again changing and creating uncertainty for the future. This issue was addressed earlier this year in the Energy Security Report to the President in which we looked at the energy security implications of the 1986 oil price collapse and the growth of oil imports. The report concluded that by the mid-1990s we could be dependent on imports for more than half the oil we use, much of it coming from the volatile Persian Gulf area. In assessing our energy security, however, we did not look just at oil, but at all energy resources - including renewables - and how they might contribute to the Nation's energy security.

The Benefits of Renewables

We concluded that, in time, the United States and the world will rely more and more on renewable energy sources. Currently renewable technologies provide about 6 quads, or 9 percent of the U.S. energy supply, primarily from hydropower and biomass technologies. The other renewable energy sources

contribute less than one percent of total U.S. energy. Photovoltaics, biomass fuels, solar thermal electric power, wind energy, and others, will continue to grow and, as the technologies develop, have the potential for significant energy supply contributions in the early part of the next century. While no energy source is totally exempt from impacting our environment, renewable resources are among the most benign. In operation they do not consume fuels or have resulting effluents characteristic of fossil energy systems.

Renewables' Contribution to Energy Security

We need to employ every practical option we have to deal with threats to our energy security. By its very definition, renewable energy, in principle, can significantly contribute to our energy mix when available in sufficient amounts and at reasonable cost. Even the most optimistic projections do not suggest that renewables alone can solve our near- to mid-term oil-based energy security problems, but they can help.

Renewables in the 21st Century

Recognizing the hazards of forecasting, we have projected from the present into the future in order to gain an order of magnitude estimate of the role that renewables may play in the first decade of the 21st century. In our energy security assessment we projected that renewables would reach a level of about 10 quads, or 10 percent of U.S. energy use in 2005. We anticipate a 46 percent growth between now and 2005 for the current mature renewable technologies -- hydroelectric power, and wood and woodwaste burning, raising their contribution to 8.6 quads (or 4 million bbl/day oil equivalent). Of the

other renewable technologies — wind, photovoltaics, solar thermal, ocean thermal, geothermal, and biofuels — we project that in 2005 their contribution will be about 2 quads. Half of these quads will be electric power that will displace about 470,000 barrels of oil equivalent per day, while biofuels will displace another 230,000 barrels of oil per day.

Research & Development Accomplishments

The Administration's approach to achieving renewable energy's potential is through a far-sighted program to improve the technology base the private sector needs to make development and investment decisions. Competition among these and other energy sources will determine each energy source's contribution to future U.S. energy supplies.

Every area of the United States has some renewable resource in sufficient quantity to constitute a significant supply. The great diversity of the technologies and applications that are possible from the various renewable resources provides for a significant combined potential contribution to the nation's and world's energy supply. This diversity allows for the matching of end use energy requirements for heat, light, electricity, or fuels. These technologies can, therefore, have applications throughout all economic sectors: residential, commercial, industrial, transportation, and utility.

Research performed to date has solved many problems, reduced uncertainties, and established a solid technical base for future research. This research has allowed scientists to establish specific technical and performance goals that indicate the technologies' ability to become attractive

energy supply alternatives. Research results have already yielded cost reductions by as much as a factor of 10, doubled lifetimes, and 400 percent improvements in efficiency.

An example of such progress is the case of photovoltaic systems, which in the past ten years have seen costs reduced from more than $600 per watt to less than $5 per watt; life expectancies have increased from less than five years to nearly twenty years; and efficiencies have more than doubled. In the case of wind energy systems, research and development in the 1980s have resulted in major technical innovations that have lowered production costs and increased efficiency and reliability. As a result, the cost of wind-generated electricity has been reduced more than ten-fold since the late 1970s, to a 30-year levelized cost of 10-15c/kWh.

Advances have also been achieved in the wide range of biomass resource technologies. The productivity of woody biomass through short rotation intensive culture has increased by three hundred percent, nearing the goal of 9-12 tons/acre/year. Just a few years ago, cellulose to ethanol conversion processes converted only 60 percent of the cellulose to ethanol, with resulting ethanol concentrations of only 2 percent. Now, yields of greater than 90 percent are achieved with ethanol concentrations approaching 5 percent. In the last ten years the estimated cost of ethanol processes has been reduced from $4.00 per gallon to less than $1.50 per gallon. Research has increased our understanding of the complex interactions between organisms involved in anaerobic digestion for the production of methane. We have

increased conversion efficiency while decreasing solids residence time. These factors have contributed to decreasing the cost of methane from $8 per million Btu to less than $5 per million Btu.

Passive and active solar components for buildings have shown progressive improvements in both costs and efficiencies. The energy delivery costs associated with active solar water and space heating systems have been reduced by half in the last ten years. Collector efficiency improvement has been evident in the increase in delivered energy from 631 Btu per square foot in 1977 to 865 Btu in 1984. At space heat/domestic hot water temperatures, system efficiency has as much as doubled. Experience with solar thermal systems has led to significant reductions in costs. The earliest glass/metal heliostats, such as those installed at Solar One in 1980, carried a system cost of $900/$m^2$. Silver polymer and silver steel technologies have enabled the production of heliostats at a cost of $40-80/$m^2$. Total system costs have also declined significantly, from a 1980 level of $14,500/kW to $3,200/kW today.

All geothermal energy types except magma have been penetrated by successful wells and energy extraction and conversion have been experimentally verified. Nearly 2,000 MW are on line at The Geysers steam field in California. Geothermal technologies are expected to contribute 4,700 MW to the Nation's electric supply by 1995.

Research Potential

Technological change in all energy technologies can support improved efficiency, increased resource recovery, and development of substitute options and permit use of formerly unusable resources. Technology advances will determine renewable energy technologies' cost-competitiveness and their potential energy contribution. The nation's scientific and engineering capabilities and expertise provide optimism regarding the long-term development of competitive renewable energy technologies.

While use of renewables will continue in building design and in industrial processes, in the nearer term we are likely to see the most practical applications of new renewable technologies in remote or stand-alone systems. Photovoltaics are currently in use in many developing countries for village electrification, water pumping, communications, and refrigeration. This will continue to be one of the most promising renewable technology markets in the near term. Small- to medium-sized wind energy systems will provide small but growing amounts of electric power, some to utility grids, while research continues that will eventually result in much larger wind systems that provide significant portions of a utility's generating capacity. Geothermal electric systems currently produce baseload electricity at a cost that is competitive with coal and nuclear electric generation. Current research developments that have produced new-materials and components are improving the prospects for the continued incorporation of passive and active solar components in both commercial and residential buildings.

Research developments and continued industry commitment to renewable energy technologies indicate an important role for these technologies in small system applications in the near future and in larger electric generating applications beyond 2000.

The establishment of an adequate technology base upon which industry can develop competitive products for the next decade will involve a sustained research commitment well in advance of potential payoffs. The goal is to advance the technology while avoiding interference with the capacity of industry to develop specific commercial products and services. DOE focuses its research efforts on those technologies with the greatest long-term promise for contribution to the energy supply mix. To this end, Federal research funds are concentrated in basic and applied research, the scientific and engineering research necessary to improve the understanding of basic resource and technology phenomena, methods to use these resources for producing competitive and useful forms of energy, and important crosscutting technologies for storage of energy and for reliable and efficient management of the electric energy supply network.

Competitiveness

Research in renewable energy demonstrates the importance of innovation and technology in producing a vigorous economy in today's world. As we have learned in our own national experience, the key to productivity and economic vitality is the innovation spawned in a competitive marketplace. Technological innovation through research and development is the key to affordable, reliable energy supplies and products. It is also the key to U.S.

competitiveness in renewable energy and other high technology industries. Contrary to some assertions, the U.S. is still a world leader in renewable technology and is in good position to achieve the breakthroughs and major advances that will bring renewable energy technologies to practical fruition. For example, the U.S. still dominates the power module market in photovoltaics; major gains in PV efficiency and production technologies are coming from U.S. labs and manufacturers. U.S. research leads the world in gaining new understanding of thin film photovoltaic devices as well as in devising improvements in large area modules. U.S. research achieved the 50 percent installed cost reductions that the wind turbine industry has realized since 1981. We also have the most advanced geothermal technology and largest installed capacity in the world.

International

Recognizing the great potential for U.S. renewable energy products in the foreign market, DOE and other federal agencies involved in international trade are actively investigating and promoting potential markets and products through the efforts of the Committee on Renewable Energy Commerce and Trade (CORECT). CORECT's primary mission is to reduce the major barriers to exporting U.S. renewable energy products -- lack of market information and inadequate financing. In its 2-1/2 years of existence CORECT has made some significant accomplishments in diminishing these barriers. Through CORECT's numerous conferences, workshops, market studies, collaborative efforts with international funding agencies, and efforts to resolve financing barriers, the

renewable energy industry has realized new foreign market opportunities. CORECT is committed to continuing these and other efforts to realize the large foreign market potential that has yet to be tapped.

Pending Legislation

While insight into future required funding levels is gained through the Department's multi-year planning process, specific program research activities are the result of assessments of research progress needs and progress at a particular point in time. Technical advancements are subject to breakthroughs that result in changes that are unpredictable with regard to time and magnitude. Because the Federal government's policy is to achieve budget deficit reduction goals, only the highest priority projects can be supported. We therefore cannot support the establishment of the specific funding recommended in the Solar Development Initiative Act of 1987 (S. 1320) a section dealing with out-year (FY88, FY89, FY90) budgets. The balance between budget restraint and continued research and development is a necessary but difficult pursuit. Another section of the bill deals with demonstration projects. DOE believes that the real challenge is developing new renewable energy technologies, not demonstrating existing technologies at intermediate stages of development. DOE agrees that the activities of the CORECT and other federal agencies can benefit overall renewable energy technology development and that these activities need to be continued.

The Department of Energy supports the recognition of the importance and potential of renewable energy technologies contained in the Renewable Energy

and Energy Conservation Technology Competitiveness Act of 1987 (S.1554). However, the bill's provisions may not be sufficiently flexible with regard to the diverse status of the various renewable energy technologies or incorporating the advantages of the existing research and development planning and execution processes. Because the development stages of renewable energy technologies span a wide range, a variety of research and development approaches is required. Research strategies and approaches are revised frequently to reflect research progress and needs and funding levels and planning must accommodate these changes. The current research and development planning process adequately accounts for changes, integrating advice from national laboratories, universities, and the private sector. As currently drafted, the bill places proscriptions on these processes that will limit their effectiveness.

Conclusion

The Department of Energy appreciates Congress's interest in renewable energy technologies and its efforts to encourage the advancement of these important sources of energy security, however, at this time, we cannot support either S. 1320 or S. 1554 for the reasons discussed above. I want to emphasize that we support the development and application of renewable energy technologies. We recognize that the current status of the technologies requires a longer-term perspective regarding the development of commercial products and prospects through a well-developed research program and we are anxious to direct available resources to supporting the high priority research needs of the U.S. renewable energy industries.

Senator FOWLER [presiding]. Miss. Fitzpatrick, did you want to——

Mr. MARTIN. She's here just to answer the questions.

Senator FOWLER. Good. Mr. Secretary, both of you are welcome and I thank you for the summary of your testimony. Anything you want to put in the record will be welcome.

I know that the Administration's philosophy is, as you stated clearly, to continue to use, as you said, your limited funds to further research and development. But where does the follow-through come from? How are we going to get the application, the demonstration that these systems, as you have said, do work and can be a growing percentage of your chart with just a little bit of help in what I'll call, for lack of a better term, the follow-up, the follow-through after the research and the development?

Four billion dollars apparently everybody agrees on—20 years of American taxpayers' money. That has done so much for development. We're not getting the follow-through. How are we going to get that?

Mr. MARTIN. Let me say, I think we do follow through. I think our analysis that we reported on energy security indicated that under market conditions with prices rising, even modest amounts, we see a fifty-fold increase in that one percent wedge that I showed you. We see a 50 percent increase in hydro and biomass. So we think that, indeed, there will be progress.

I think our objective is to put the money into the basic research so we can continue to improve the cost competitiveness of the technology and keep getting that curve further down. As we get that curve further down in R&D and as the price of oil recovers and these technologies become more competitive, we believe industry will naturally pick them up.

The problem we have with choosing demonstration projects is that it's pretty hard to choose winners and losers. Government has not been particularly good at that. We think that is the appropriate place for the winners and losers to be followed up—in the marketplace.

But I think we have a very important responsibility to improve the R&D.

Senator HECHT. Mr. Chairman, may I ask one question?

Senator FOWLER. Certainly. The Senator from Nevada.

Senator HECHT. Would you mind taking the white chart and pushing that down, the one in back of it, please? I appreciate this, Mr. Chairman.

You have nuclear there as 6 percent. I thought we were about 12 percent nuclear.

Mr. MARTIN. Nuclear is 16 percent of total electricity, if you put it as total primary. But that's an interesting chart. Let me say that we think renewables, by 2005, can meet 17 percent of our electricity needs in this nation, which is about what nuclear power does today.

Again, let me emphasize that does include hydro. So we see these technologies coming on and penetrating the market in a way that enhances our energy security.

Senator HECHT. What do you see oil at that time?

Mr. MARTIN. Thirty-eight percent.

Senator HECHT. And coal, what do you see that in the year 2000?

Mr. MARTIN. Up to 25 percent maybe.

Senator HECHT. Natural gas?

Mr. MARTIN. Probably level.

Senator HECHT. Thank you very much, Mr. Chairman.

Mr. MARTIN. But don't believe any of my projections, Senator. [Laughter.]

Senator FOWLER. Well, I'm glad you said it.

Mr. MARTIN. I answered the question.

Senator FOWLER. Mr. Secretary, suppose the Congress accepts the funding proposed by the Administration for the renewable R&D part. Would the goals, do you think, that we set for renewable energy programs in Section 4 of the Senate bill 1554 be achieved?

Mr. MARTIN. Senator, I think that's where we can agree with your bill. I think your goals are very commendable and that we actually share them. In fact, we have a research plan, I believe, that delineates our goals, and they're very parallel. We think again that the emphasis on the research will bring us to that level.

But I'd like to ask Donna Fitzpatrick, who knows more specifically about that, if I may, to answer your question.

Senator FOWLER. Fine.

Miss FITZPATRICK. Senator, as you know, we publish long term research plans and goals for our programs. I think it's very interesting that we really do agree on where these technologies should be heading.

For example, in photovoltaics we agree that a system should have a 30 year lifetime, as your bill specifies. Our cost goals are roughly the same. We're all looking to produce electricity from solar thermal, from photovoltaics, from wind, in the range of four or five or six cents a kilowatt hour, which should be competitive with almost any other alternative.

We are looking for solar thermal to produce not just electricity but also direct heat in the range of eight or nine dollars a million Btu's, which is about the same as what your bill proposes. So I think we really are in very substantial agreement on what the potential for the technologies should be and where we should be aiming.

Senator FOWLER. Does the Administration support this bill?

Miss FITZPATRICK. We support those goals. I think the discussion is about how we should get to those goals and what is the best use of our resources to get there.

Senator FOWLER. So what's the answer?

Mr. MARTIN. No. We don't support it.

Senator FOWLER. Why don't you support it?

Mr. MARTIN. I think the emphasis on demonstration causes some concern. I think it really is almost a very delineated how to do it manual. It reminds me of a lot of the good intentions we had in the 1970s.

When I came up here to testify we worked hard with the Congress and others to try to delineate a national energy policy. It was almost as if we knew the best way to get there. I think it is with good intentions and I think the goals are worthy. It's just that we think there is probably almost too much detail of how to do it, if I might say so. That's my personal opinion.

Senator FOWLER. You might say so, but I'll tell you what your response reminds me of. If you walked around the White House today and even mentioned the term "supply side economics", they would shoot you. It is a term forbidden for any Administration figure to refer to because it has become so discredited over the last two or three years as the best intentions of the 1970s, to use your phrase. It only led us to extraordinary deficits and economic policy that the nation is trying to dig out of.

What I'm worried about is that your approach is sort of like supply side energy. All of these things are just going to happen magically if we keep going along in research. But everybody else is going to show that the application is possible, affordable, and remarkable in its results when there is a little help. But how you can say after an approximate 80 percent cut over the last five or six years in this area, that suddenly we're going to do all of this research that is going to be magically transformed by the marketplace. There is certainly nothing that would support that.

Mr. MARTIN. I think the record shows that development has given us considerable benefits. I think if we had unlimited money it would be delightful to do demonstration projects. But we do have to choose between priorities. Let's take synthetic fuels, for example.

This country launched forward on synthetic fuels based on technology 40 years old. Because of that we now have technology sitting out at Great Plains, for example, that produces beautiful gas, but at about three times what the market will allow.

What I'm saying is, with limited resources, let's put it into research so that by the time we do the demonstration projects, by the time industry does pick it up, we have a better technology. I don't see that demonstration leads it to us. It just drains valuable dollars.

Senator FOWLER. We'll see what the Japanese do with photovoltaics in the next five, six or eight years. We'll see who is right, which country has taken known successful research and development and who can turn it into commercial development. It will not be this country.

And all of that was our research. It wasn't the Japanese. I know you won't quarrel with that. It was our research that they are using, demonstrating through their application and commercial development. Even our Office of Technology Assessment says, and I quote, "Despite their long-term promise, at the current rate of development very few renewable technologies appear likely to be employed extensively in the 1990's."

I know we disagree on this, Mr. Secretary, but I want us to practice what we preach. There is nothing sacred in the bill that I have proposed, except that I want to put the rubber to the road, I want to put the hay down where the goats can get it. This business of spinning along on research and development forever and then seeing our international competitors take our work and turn it into practical applications simply because we are talking about supply side energy and how the market is going to take care of this—It just hasn't happened that way.

There is no springboard in any of this that shows that it is likely to happen over the next decade without a little help in applying it and demonstrating that it can be successful.

Mr. MARTIN. Senator, let me take an example. You mentioned OTA. I've been in touch with OTA too. What they tell me about your bill is that you're almost too detailed in trying to pick winners and losers. As they say, it's an uneven bill because you go into such disaggregation with it. That is really kind of what I am saying too.

Senator FOWLER. I would be perfectly willing to have the resources of your office tell me which ones—I'll pick your winners. But the demonstration projects in the bill that you were mentioning, the cost, that's $9.3 million a year. That's what it costs to cool this side of the Capitol.

Well, I do appreciate your coming today. I know it was on short notice. With all of the questions that are being raised now about the energy security of our country, I think we've got a great opportunity. I don't want to wait until the next administration, Republican or Democratic.

I'm tired of us running all over the world because we've got to have the oil and worrying about fielding three or four armies. When we can do so much, to sit around arguing about which step comes first or who is going to do it—We know how to do it.

Just to be about as moderate as I can, penny wise and pound foolish. I'll give you the last word.

Mr. MARTIN. We appreciate coming up here to talk about renewables. I don't think they get enough attention. Again, you'll be hearing from some people like Scott Sklar and Frank Potter today who will, I think, give you an appreciation that these technologies have come a long way. That is the impression I get. A lot more has happened than I had really felt had been accomplished.

I couldn't agree more with you about trying to get off oil and trying to bring on these indigenous energy resources. I must admit, your own state is a real leader in this as well. I was very impressed with the plants I saw down there.

One of the things I will tell you, as the testimony evolves today and the people have good ideas about priorities, I hope we can talk about it with them and continue this discussion because I want you to know that all the knowledge does not rest in the DOE. I think building a consensus with the Congress and with other experts is very important.

We look forward to listening to the testimony today and working together.

Senator FOWLER. Thank you very much. Thank you, Miss Fitzpatrick.

Senator BUMPERS. Mr. Chairman, I ask unanimous consent——

Senator FOWLER. Excuse me. I didn't see you there.

Senator BUMPERS. That's okay. I ask unanimous consent that a statement of mine be inserted in the record prior to the beginning of the hearing.

Senator FOWLER. Without objection, it will be so ordered.

We certainly welcome the senior Senator from Arkansas, Mr. Bumpers.

The next panel will be composed of the Honorable Sharon Pollard, Secretary, Executive Office of Energy Resources, State of Massachusetts, Office of the Governor; Mr. Scott Sklar, Executive Director of the U.S. Export Council for Renewable Energy; Ms. Omi Walden, Walden Associates, on behalf of the International Association of Sheet Metal Workers; and Mr. John Corsi, Chief Executive Officer of the Solarex Corporation in Rockville, Maryland.

Ladies and gentlemen, we welcome you. I know Ms. Pollard has some time constraints and a plane to catch, so I will want to call on her first.

Before I do, I know you've been asked and I appreciate all of your trying to summarize your testimony. Your complete statements will be made a part of the record. It may be helpful to you—I hope so—to let me just throw out two or three things that we are very interested in so that you might want to incorporate it into your testimony so that we don't go through all of the questions at the end.

We would like to know what is the most important help that Congress could give to the renewable energy development in all of its facets at this time; Whether either of our bills—the bill sponsored by Senator Bumpers and me—meets these needs adequately; if not, your suggestions on amending them.

In your opinion, what will the taxpayers of the United States get and when will they get it. That's a very important component. When will they get it as a return on the Federal investment in renewables. Please be as specific and as quantitative as you can.

One question that has been handed to me. The Administration has testified that renewables, other than hydro and woodburning, will contribute about two quads out of about a hundred quads to our energy supply in the year 2005. Do you agree with this estimate? Explain why.

Ms. Pollard, welcome. I'll let you begin.

STATEMENT OF SHARON M. POLLARD, SECRETARY, EXECUTIVE OFFICE OF ENERGY RESOURCES, COMMONWEALTH OF MASSACHUSETTS, OFFICE OF THE GOVERNOR

Ms. POLLARD. Thank you, Senator Fowler, Senator Bumpers.

I'd like to begin by thanking you for the leadership that you have shown in paying attention to a very, very important issue. Putting your money where your mouth is, so to speak, in presenting legislation that is comprehensive in nature, legislation that will in fact, we believe in Massachusetts, if passed into law will really help renewables become an important part of our energy future, which we believe is very important.

I would like to support, if I may, both bills, Senate bill 1320 and Senate bill 1554, and just mention that in addition to the Commonwealth of Massachusetts, I am here also to testify on behalf of the National Association of State Energy Officials who wish also to be recorded as being in strong support of both pieces of legislation.

Senator FOWLER. That will be recorded.

Ms. POLLARD. Thank you. And we will work with you to do whatever it is that we can to make sure that this important piece of legislation is the law of the land.

I just wanted to start by giving you a little sense of why Massachusetts is so interested and involved in renewable energy. As you are probably aware, for the citizens of New England and of our state, the 1970's was a decade of continual energy shortages and price spikes.

It became important, and we recognized it as being important, that we needed to spend a great deal of time in making sure that state government was going to give a commitment to the development of renewal energy in a cost effective way. If you will allow me for a few minutes, in a second I'm going to talk a little bit about what Massachusetts has done, both in the area of renewable energy and specifically in photovoltaic electric, which is a very important part of your bill.

We looked at, in 1973, a situation where about 89 percent of the energy that we used came from oil. A great deal of that 89 percent was imported oil. Today when we looked back over the work that we've done in the past ten years, we've dropped that number to 80 percent. We've moved a little bit, we've had some success. But we still have a long way to go.

We believe that one of our office's primary functions as a Secretariat of Energy, that our function is to promote and enhance the development of energy conservation and renewable energy resources. To this end, we believe that these two bills are very important, not only for Massachusetts and New England but for the entire country.

I wanted to mention that between the years of 1975 and 1985, the U.S. Government spent a total of $4 billion on renewable and solar energy research and development, and $2 billion on tax incentives. So as a result, over $36 billion of imported petroleum was displaced, something that we consider to be very important.

I think this investment typifies the progressive attitude of the U.S. Congress, even when executive branch support for renewable energy has certainly diminished and there is not much of it left. In Massachusetts, we have programs for the development and the use in Massachusetts of renewable energy. We were one of the first states to see that and to incorporate those programs.

But we also have a particular interest in the development of photovoltaics, solar electric. It's an energy technology that we believe has tremendous potential, and is prominently placed in the bill that both Senator Fowler and Senator Bumpers has before us today.

The cost of photovoltaics has dropped dramatically. We believe it is as a result of the research and development that has gone on in this particular field in the past. Photovoltaics was once available for only outer space and other exotic high technology purposes. Photovoltaics, however, now is inexpensive enough for widespread and large-scale terrestrial use.

We believe that the goals that are set forth in the legislation before us in S. 1554 are achievable if in fact they are undertaken by a consistent and persevering leadership with long-term goals in mind. As a result of the increased research and development effort, the cost effective market for photovoltaics will expand rapidly, we believe.

Once limited to remote communications and navigation equipment, photovoltaics are now the appropriate choice for agricultural, health and consumer products, and will become the choice for utility and industrial purposes. We believe it is unfortunate that the United States, which long held the cutting edge in photovoltaic technology, has lost the lead in both production and expertise—a question that you addressed, Senator Fowler, to the Department of Energy. This has been directly due, we believe, to the premature withdrawal by the Department of Energy from many aspects of photovoltaic R&D, as well as other renewables.

An 80 percent drop in Federal R&D has forced the United States to abandon many of the most likely avenues of research success, especially in applications and production techniques, which will bring down cell costs. It is interesting that you mentioned the Japanese. As we are all so painfully aware, the Japanese have done an excellent job in perhaps taking over the premiere position that the United States once had. They, I believe, hold the majority share of the market for photovoltaics in the world. And the Australians, as well as the French and the Germans, have become particularly active in photovoltaic research and development, and their governments have been very willing to come forth and put up the money to make sure that their program of research is going to be fully developed through the end of the century, something that we aren't doing in the United States. I think we will probably pay for it.

We believe that with short term projections, predicting a global market of a thousand megawatts by the year 1995 of photovoltaic electricity and long term projections proposing a 30,000 megawatt market by the year 2010. The declining U.S. share of the market projected above reflects a devastating consequence for American industry in the future.

The National Science Foundation that the largest relative decrease in the Reagan Administration's budget for Federal research in 1987 was scheduled in renewable research and development. Conversely, the most significant increases in R&D money have gone into nuclear. This plan is one, we believe, of the most remarkable plan of shortsightedness at best, and probably will have some catastrophic effects for the country in the future.

I just wanted to spend 30 seconds in talking about an interesting project that we have in Massachusetts, something I think you will find interesting. We have developed and will continue to develop a long range program to promote photovoltaic technology. We did a major study for the governor in 1985 which tried to deal with some of the barriers that we saw in photovoltaic development, things such as limited public and private resources which certainly limit the ability for some research and development and which prohibits some progressive marketing.

But we found that there was a difficult consumer identification to photovoltaics due to technological advances and the diversity of end user applications. There was an unfamiliarity of emerging technologies to decision makers and some end users. And finally, that financing issues that were unique to this technology had not yet been addressed and were still problematic.

To overcome these barriers the Commonwealth of Massachusetts, something that our governor is particularly interested in, developed a comprehensive program in concert with industry and academia. The Massachusetts Photovoltaic Center was established with four major components.

The demonstration service explains the technology and its applications to decision makers all over the country and from around the world. The export assistance service identifies market ideas and leads from the global community. The technology and training service provides expert courses and conducts applications research. The financial service coordinates multilateral lending and donor organizations, and provides an evaluation service to identify the cost effectiveness of the project.

In addition to that, with the renewal energy bond program that we have in the Commonwealth, we have something called the Massachusetts Photovoltaic Utilization Program, which was modelled after the Federal program some years ago. We have identified $1 million in cost effective state government applications for which we are now in the process of installing photovoltaics.

In addition to that, we have spent about $30 million of our state resources to provide some cost effective renewable energy applications in state government and in public buildings throughout the Commonwealth of Massachusetts.

So I just wanted to end. I probably used five, or maybe six or seven minutes.

Senator FOWLER. No. Twelve.

Ms. POLLARD. Oh, really? I'm sorry.

I want to thank you for your leadership. There really isn't a lot of it around when it comes to this particular issue. It's not only important to Massachusetts and New England, where we have a real dependence on oil and imported oil. I think it's important to the country because recent sources have shown that we can in fact produce a lot of energy to meet our energy needs from renewable energy.

Thank you.

[The prepared statement of Ms. Pollard follows:]

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TESTIMONY OF SHARON M. POLLARD, SECRETARY

EXECUTIVE OFFICE OF ENERGY RESOURCES

COMMONWEALTH OF MASSACHUSETTS

BEFORE THE

U. S. SENATE COMMITTEE ON ENERGY AND NATURAL RESOURCES

SUBCOMMITTEE ON ENERGY RESEARCH AND DEVELOPMENT

Thursday, August 6, 1987

Thank you Mr. Chairman and members of the Subcommittee for this opportunity to appear before you this afternoon and express my support for two bills: S.1320, "The Solar Development Initiative Act of 1987" and # S.1554, "The Renewable Energy and Energy Conservation Technology Competitiveness Act of 1987."

We are all aware that the 1970's was a decade of continuous energy shortages and spiralling prices of gasoline, oil, and natural gas. During that period, the Commonwealth of Massachusetts became painfully aware of its particular dependence on unreliable and costly imported fossil fuels.

At the time of the Arab oil embargo, Massachusetts was dependent on oil for 89% of its energy, and was more adversely affected by the embargo than any other state in the nation.

Today, that percentage has dropped to under 80%. But even with that improvement, Massachusetts is still too vulnerable to economic dislocation caused by supply interruption or high prices. For that reason, the Commonwealth has continued to aggressively promote greater diversity of supply, through the development of our indigenous energy resources, the use of load management as a source of supply, and the encouragement of alternative fuels to oil in our energy mix.

Because one of my office's primary functions is to promote and enhance the economic development of energy conservation and renewable energy resources, I am here to testify on the merits and importance of S.1320 and S.1554.

Between 1975 and 1985, the United States government spent a total of $4 billion on solar and renewable energy research and development (R&D) and $2 billion on tax incentives. As a result, over $36 billion of imported petroleum was displaced. This investment typifies the progressive attitude of the Congress even when Executive branch support for renewable energy has been diminished.

We in Massachusetts have taken a particular interest in the development of photovoltaics as an energy technology with tremendous potential. The cost of photovoltaics has dropped dramatically as a result of federal R&D funding. Once available only for outer space and other exotic high tech applications, photovoltaics are now inexpensive enough for wide-spread and large scale terrestrial use. In 1980, for example, a kilowatt panel cost was $10,000. By 1984 the price had dropped to $7500. PV panels are now obtainable retail at between $5000 and $7000 per kilowatt. With sustained joint federal and industrial R & D the cost per kilowatt can be reduced much further. The goals set forth in S.1554 are achievable if undertaken by a consistent and persevering leadership with long-term results in mind.

As a result of increased research and development efforts, the cost-effective market for photovoltaics will expand rapidly. Once limited to remote communications and navigation equipment, PV's are now the appropriate choice for agricultural, health and consumer products, and will become the choice for utility and industrial purposes. Global shipments of PV panels in 1980 were 3.3 megawatts. In 1984, due to lowered costs and improved marketing, global shipments were 25 megawatts, an increase of 700%. Projections to 1990 and 1995 show the potential for at least 300 megawatts and 1000 megawatts respectively.

The only limits to growth reflect a limit of will and vision rather than technology. When almost 2 billion people around the world are currently without electricity at all, and price, pollution, and supply problems associated with petroleum continue, the potential world-wide market for photovoltaics is virtually unlimited. But we must have the foresight and the will to act decisively.

Unfortunately, the United States, which long held the cutting edge in PV technology, has lost the lead in both production and expertise. This has been directly due to the premature withdrawal by the Department of Energy from many aspects of photovoltaics R&D. An 80% drop in federal R&D has forced the U.S. to abandon many of the most likely avenues for research success, especially in applications and production techniques which will bring down cell costs.

As the DOE budget for PV's has shrunk, the Japanese R&D budget has grown to well over $60 million annually, 50% greater than ours. When considered on a per capita basis, both the Japanese and European R&D budgets currently far exceed that of the U.S. Moreover, other countries have provided national support for export and financing of their own country's product. Australia, for example, provides 70% of all export promotion costs. The Japanese

provide direct assistance to Japanese export costs, and subsidies for their product. As a result, the Japanese global market share has increased from 15% in 1980 to 48% in 1986, while the U.S. share has fallen from 75% to 27% in the same period.

Along with the Design Assistance Center at Sandia, the only U.S. program to assist the renewable export industry is the Committee on Renewable Energy Commerce and Trade (CORECT). Budgetted at a mere $900,000 in FY '86 and $800,000 in FY'87 this committee combines the resources of the Department of Energy, Department of Commerce, the Export-Import Bank, the Overseas Private Investment Corporation, Small Business Administration, Department of State, the Agency for International Development and other federal agencies to develop techniques and programs to promote US renewable exports. While this program is a laudable attempt to assist an emerging industry, it is clearly overshadowed by other market forces. For it to become significant, the funding levels of S.1554 are necessary.

With short term projections predicting a global market of 1000 megawatts by 1995 and long term projections proposing a 30,000 megawatt market by 2010, the declining U.S. share of the market reflected above predicts a devastating consequence for American industry in

the future. Translated into 1985 dollars, the market in 1995 will be approximately $2 billion and in 2010 approximately $30 billion. It is incomprehensible that the United States should permit this loss of a world market for another U.S.-pioneered technology.

The National Science Foundation has noted that the largest relative decrease in the Reagan Administration's budget for federal research in 1987 was scheduled in renewable R&D. Conversely, the most significant increases in R&D monies have gone into nuclear power. This plan is one of remarkable shortsightedness at best, and catastrophic destructiveness at worst.

Massachusetts, on the other hand, has developed a long-range program to promote photovoltaic technology. In a 1985 study of PV's evolution, the Commonwealth identifies the barriers to further development as:

* limited public and private resources, which limit R&D and prohibit aggressive marketing;
* difficult customer identification due to technological advances and diversity of end-user applications;
* unfamiliarity of emerging technologies to decision-makers and end-users; and
* financing issues that were unique to the technology and had not been addressed.

To overcome these barriers, Massachusetts, under the leadership of Governor Michael S. Dukakis, developed a comprehensive program in concert with industry and academia. The Massachusetts Photovoltaic Center was established with four major components:

* the Demonstration Service explains the technology and its applications to decision makers from around the world;
* the Export Assistance Service identifies market leads from the global community;
* the Technology and Training Service provides expert courses and conducts applications research; and
* the Financial Service coordinates multilateral lending and donor organizations and provides an evaluation service to identify the cost-effectiveness of projects.

Additionally, the Commonwealth developed the Massachusetts Photovoltaic Utilization Program (MassPUP). With the cooperation of other state agencies, $1 million in cost-effective applications were identified in state-owned facilities. Applications include security telephones on the Massachusetts Turnpike and communications devices for law enforcement and state park and recreation facilities. As PV costs continue to fall, more applications will become cost-

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effective and Massachusetts will broaden its implementation program. But, Massachusetts cannot and should not do it alone.

A national development policy for photovoltaics is both desirable and necessary. The benefits of such a policy are not only long-term but immediate as well. PV's can provide a significant share of our national electric supply. It can provide billions in export revenues, and improve the nation's balance of trade. It can promote national security by reducing our deficit and our dependency on imported oil. But there must be a commitment on the part of both the Congress and the Executive Branch to achieve these goals. The federal government as procurer is the largest single market in the world, but as yet is virtually untapped. The Department of Defense has identified 21,000 applications in the Navy alone, but has only attempted 80 installations. The Department of Energy's own Energy Research Advisory Board has stated that an enhanced federal role in R&D would allow renewable technologies to supply as much as 80% of the nation's expected energy demand by the year 2010. With the energy goals of S.1554, the U.S. can re-take the world leadership in securing pollution-free energy resources and make them available to the world market, reaping financial benefits while it helps to create a more livable world.

I applaud the leadership that Senator Fowler, Senator Bumpers, the cosponsors of these bills, and this Committee have shown in developing S.1320 and S.1554. Passage of these bills will help to fill the vacuum of national leadership on renewable energy and will reaffirm our technological pre-eminence, while providing a safe, reliable, and renewable energy source for ourselves and for those around the world in need of energy for their survival and their self-improvement. I commend your foresight, and I thank you for the opportunity to appear before you today.

Senator FOWLER. Thank you, Ms. Pollard. I know you do have a lot to brag about. We are proud of the leadership of the State of Massachusetts. I will tell your governor that you made a very effective presentation. I think he's in my state more than he is in yours.

Ms. POLLARD. I think that's true.

Senator FOWLER. So I may see him before you do.

Mr. SKLAR.

STATEMENT OF SCOTT SKLAR, EXECUTIVE DIRECTOR, U.S. EXPORT COUNCIL FOR RENEWABLE ENERGY

Mr. SKLAR. Thank you, Senator.

I am representing an umbrella group of the nine national renewable energy trade associations who form the U.S. Export Council for Renewable Energy to promote U.S. exports of alcohol fuel, biomass, hydro power, passive solar, photovoltaics, solar thermal, wind, and wood energy technologies.

Our country is in danger of losing our technological dominance and resulting lucrative world markets, not due to deviousness of our international competitors, but rather U.S. government indifference or inaction. S. 1320 and S. 1554 represent the first step in reasserting U.S. policy back to its renewable energy industries to maintain and increase our world markets.

The U.S. industry wants to specifically thank Senators Bumpers and Fowler for introducing these bills. Our international competitors are anxiously waiting for the U.S. to relinquish our role. They can fill the technology void themselves. I brought some charts with me to show that I could make charts as good as Bill, I hope.

But what the charts show is the mercurial funding of R&D obviously.

Senator FOWLER. I think their charts were better actually.

Mr. SKLAR. Well, they spent a lot more money than I did, Senator. But I wanted to point some things out.

Obviously in this first chart here, you see that our international agency energy countries, our competition, basically they are now above us jointly in 1982 in R&D funding. But in specific technology, Japan has surpassed the United States in photovoltaics research, Federal funding. Sweden has surpassed the United States in biomass. India and the Netherlands have surpassed the United States in wind funding.

They are doing that because they see a lucrative market out there. These countries' Federal budgets in R&D are so much smaller than ours. So they are watching for the future here. And I brought charts on every technology just to give you a sense that we are being outdistanced by our competition, and they are all cutting their Federal budgets, they are all going through Gramm-Rudman tests.

But the fact of the matter is that they are surpassing us in R&D. The recommendations for solar R&D funding in the Bumpers bill and broad renewable energy recommendations in the Fowler bill are the absolute minimum Federal effort that must be maintained in order for our industries to be globally competitive. Now for some specific comments.

The U.S. taxpayer pays for energy use in all Federal building facilities. Our international competitors have adroitly instituted Federal procurement programs. They do that because it's important to build your domestic market if you're going to be able to compete internationally.

The Mavroules amendment adopted by the Congress in the Defense Authorization Act requires procurement of renewable energy devices for cost effectiveness, and has been a useful tool in obtaining a foothold in the military market.

Government is spending billions of dollars protecting our overseas military and embassy facilities against terrorism. But according to GAO, 90 percent of these facilities are on the local utility grid, the foreign utility grid. That's not very safe from terrorism. Our competitors use their overseas facilities to demonstrate their technical superiority.

Japan puts photovoltaics on its embassies overseas because when the world sees that they have it at their institutions, they're going to be more willing to buy. The proposals in S. 1320 encouraging information dissemination, seminar programs for Federal procurement officers will add the necessary tools for U.S. industry to build the market.

Likewise, the requirement in your bill, Senator Fowler, directing the Secretary of Energy to establish a Federal energy analysis team for the inclusion of energy saving and renewable energy technologies in a set of Federal facilities will increase the experience and will increase Federal procurement.

Export enhancement. Much credit goes to a bill sponsored by Representative Wyden and Hatfield that became P.L. 98-370 to create a coordinated Federal interagency board to promote exports. It has worked. Commerce, Energy, Overseas Private Investment Corporation have been enthusiastic. But we need more than enthusiasm here.

S. 1320 offered a set of specific proposals to enhance that correct program by increasing funding a little bit; by putting set asides for the Department of Commerce which meet what our international competitors do; as Senator Matsunaga said, it expands the Caribbean Basin Initiative because the Caribbean cannot expand commercially unless they have energy; and it sets up loan set asides from Ex-Im Bank and the Small Business Administration. We need that kind of aggressiveness.

Your provisions in S. 1554 requiring that we develop a renewable energy export strategy is a useful tool. It sets goals. And finally, commercial incentives.

Our industries as an aggregate are really less than a decade old. We're under-capitalized. We're mostly small business. We do not have the kind of wherewithal necessarily to play on this theoretical playing field that the DOE is trying to tell you exists out there. It doesn't exist out there.

All the conventional energy industries were subsidized one way or another, even as we speak today. We are not necessarily asking for large increases in expenditures. We're asking for existing apparatus. The legislative initiatives in S. 1320 and S. 1554 will help our industry maintain a competitive advantage overseas. The absence of a practical national energy policy which we've had over the last

six years that is urgently needed to kick in the U.S. government apparatus so that we're not maneuvered and overrun by our competition is needed.

Both of your bills offer that to us. We believe the market for renewables is a multi-billion dollar one overseas. We hope that these provisions become law.

Thank you.

[The prepared statement of Mr. Sklar follows:]

us-ecre

United States Export Council for Renewable Energy

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American Wind Energy Association
National Hydropower Association
National Wood Energy Association
Renewable Energy Institute
Renewable Fuels Association
Solar Energy Industries Association
Volunteers in Technical Assistance
Wood Heating Alliance

TESTIMONY

by

Scott Sklar
Executive Director
U.S. Export Council for Renewable Energy

before

Senate Energy & Natural Resources Committee
Subcommittee on Energy Research & Development

August 6, 1987
Washington, D.C.

INTRODUCTION

The U.S. Export Council for Renewable Energy (US-ECRE) is the national umbrella group of the nine renewable energy trade associations promoting U.S. exports of alcohol fuels, biomass, hydropower, passive solar, photovoltaics, solar thermal, wind and wood energy technologies. The United States currently holds the technological lead in most of these technologies in which many experts believe to be a potential multi-billion dollar world market. The United States is in danger of losing our technological dominance and the resulting lucrative world markets not due to the deviousness of our international competitors but rather to U.S. government indifference and inaction.

The Solar Development Initiative Act of 1987 (S.1320) and the Renewable Energy and Energy Conservation Technology Competitiveness Act of 1987 (S.1554) represent an important first step in reasserting a United States policy role to assist our domestic renewable energy industries maintain and increase our world markets.

Our international competitors are anxiously waiting for the United States to relinquish our role so they can fill the technology and market void themselves. While the United States cuts renewable R&D, our competitors are increasing R&D, and in some cases are surpassing the United States. While the United States cuts market incentives, our international competitors are increasing market incentives to build their own domestic renewable energy industries. While the United States questions the policies guaranteeing utilty interconnection, most nations are attempting to develop implementation policies to encourage utility interconnection.

The legislative initiatives that we are testifying on today, must be viewed in the backdrop of these events. This Subcommittee has not reported out an authorization bill for sometime regarding the U.S. renewable energy programs. With hearings held earlier this year by the Subcommittee and these hearings on these two legislative initiatives, I implore you to agressively push for a positive and proactive U.S. program to promote research and development, domestic market expansion, enhanced export assistance, and an enthusiastic national policy pronouncement in support of the U.S. renewable energy industries.

RESEARCH & DEVELOPMENT

The charts displayed at the hearing and attached to this testimony show the mercurial nature of renewable energy funding worldwide. But these charts also demonstrate that in the mid-1980's most of industrial competitors are increasing their national R&D while the United States is cutting our research precipitously. Japan has surpassed the United States in photovoltaics R&D, Sweden may surpass the United States in biomass R&D and the Netherlands and India have already surpassed the United States in wind energy research.

According to a 1985 U.S. Department of Energy white paper, they assert that the United States between 1975 and 1985 spent $4 billion for renewable energy R&D, and another $2 billion during the same time period on tax incentives. And now, when this investment may finally be realized, the United States may withdraw and hand over the potentially lucrative international markets to our competitors. The recommendations for solar R&D funding in Senator Bumper's' bill, and the renewable energy R&D recommendations in Senator Fowler's bill, are the absolute minimum federal effort that must be maintained in order for our industries to compete globally.

FEDERAL PROCUREMENT

The U.S. taxpayer pays for the energy use in all federal buildings and facilities. Our international competitors have adroitly instituted federal procurement programs that benefit their countries in three specific ways. First and most obvious, federal purchases of ther domestic renewable technolgies builds their domestic industry base -- not dissimilar to how the United States built our domestic computer industry through military purchases.

Second, procurements of most renewable energy devices will save more energy and money than conventional energy applications over the life of the building or facility. Although renewables tend to have higher upfront capital costs, these technologies have lower or no fuel costs. The Mavroules Amendment adopted by the U.S. Congress in the Defense Authoriation Act requires the procurement of renewable energy devices when cost-effective and has been useful tool in obtaining a foothold in the military market.

Third, the U.S. Government is spending billions on protecting our overseas military and embassy facilities against terrorism. According to General Accounting Office study, over 90 percent of these facilities rely on the local foreign utility grids. Our international competitors use their overseas facilities to demonstrate their technical superiority. And indeed, overseas use of renewable energy technologies would be an important market stimulus. More importantly, expanded government procurement of renewable energy devices would create far more security than relying on local electric grids and back-up diesel generators.

However, Congressional directives alone don't build procurement markets. The proposals in the S.1320 encouraging information dissemination and seminar programs for federal procurement officers will add the necessary tools for the U.S. industry to build the market. Likewise, the requirement in S.1554 directing the Secretary of Energy to establish a Federal Energy Analysis Team for the inclusion of energy saving and renewable energy technologies in a defined set of federal facilities, will increase the experience and current procurement practises within a wide range of federal agencies.

EXPORT ENHANCEMENT

The U.S. government effort to promote renewable energy export activities by coordinating existing federal agencies' export programs and developing more institutionalized relationships with the domestic renewable energy industries, has been laudable. Much credit goes to the passage of P.L.98-370 which created the Committee on Renewable Energy Commerce and Trade (CORECT), headed by the U.S. Department of Energy with active participation by the U.S. Department of Commerce, Agency for International Development, Export/Import Bank of the United States, Overseas Private Investmemt Corporation, and several other federal participants.

The benefits of CORECT has been astonishing over the last two years. Working in concert with the industry umbrella group, US-ECRE, data has been published outlining renewable energy resources worldwide, country domestic energy and trade policies, market analysis, and industry site visits in the Pacific Rim and Caribbean Basin. The Departmemts of Commerce and Energy, and the Overseas Private Investment Corporation deserve special praise for their adherence to both the letter and spirit of the law.

S.1320 offers a set of specific pruposals that greatly enhance the existing CORECT program. First and foremost, the bill provides a minimum of $1.5 million over the next three fiscal years. Clearly, if the United States will not fund a modest program of industry promotion, the U.S. competitive advantage will be lost.

Second, the legislation specifically directs a similar amount be set-aside within the U.S. Department of Commerce, the agency primarily devoted to overseas commercial assistance. This new funding is essential to expand existing industry assistance efforts in actual export and joint venture projects. This proposal meets the competitive programs of our international competitors head on.

Third, the legislation expands the Caibbean Basin Initiative, the area of the world most in need of domestic energy development and the most fertile market for the U.S. renewable energy industry. US-ECRE currently is sending industry teams into the Caribbean to develop actual projects incooperation with the U.S. Department of Commerce. The proposal will surely send the correct signals to those federal agencies seeking to build the industrial and economic base of our Caribbean neighbors.

Two additional directives in S.1320 which require a .025 percent renewable energy set-aside in the Ex/Im Bank loan authority and reinstatement of the Overseas Private Investment Corporation's feasability grants and incentives program which are both extremely valuable tools for the renewable energy industries, that are predominantly small businesses. Both incentives require no additional funds yet provide certain resources under the rubrick of each existing export program. These provisions are very agressive and will definately assist the U.S. renewable energy industry in competing against a wide range of innovative programs offered by our international competitors to their industries.

S.1554's provision requiring CORECT to develop an U.S. renewable energy international export strategy, is a most useful policy tool. This requirement would foster a coordinated document that could serve as "the U.S. policy" statement regarding our renewable energy export strategy.

COMMERCIAL INCENTIVES

Because the U.S. renewable energy industry is barely over a decade old, and as a result under-capitaliized; and as stated earlier, predominantly small business, certain innovative approaches to commercializing technologies are in order.

The approach in S.1320 to re-establish programs within the Small Business Administration is very appropriate. The .025 percent of loan authority set-aside, and the allowance for establishment of 18 month lines of credit should insure SBA's cooperation which has been sorely lacking in the past. Hopefully, SBA's machinary might be prodded to assit this industry rather than the usual laissez-affair approach.

The approach in S.1554 to establish certain R&D goals and specific joint ventures is also a very useful tool. I think it's proper to allow each industry trade association of whom all are US-ECRE members, comment on the specifics. Joint ventures in R&D can be very useful for the larger companies in the industry who have some capital liquidity, but joint ventures tend to be less useful to the smaller businesses unless their contribution is limited to in-kind contributions to projects, such as staff time.

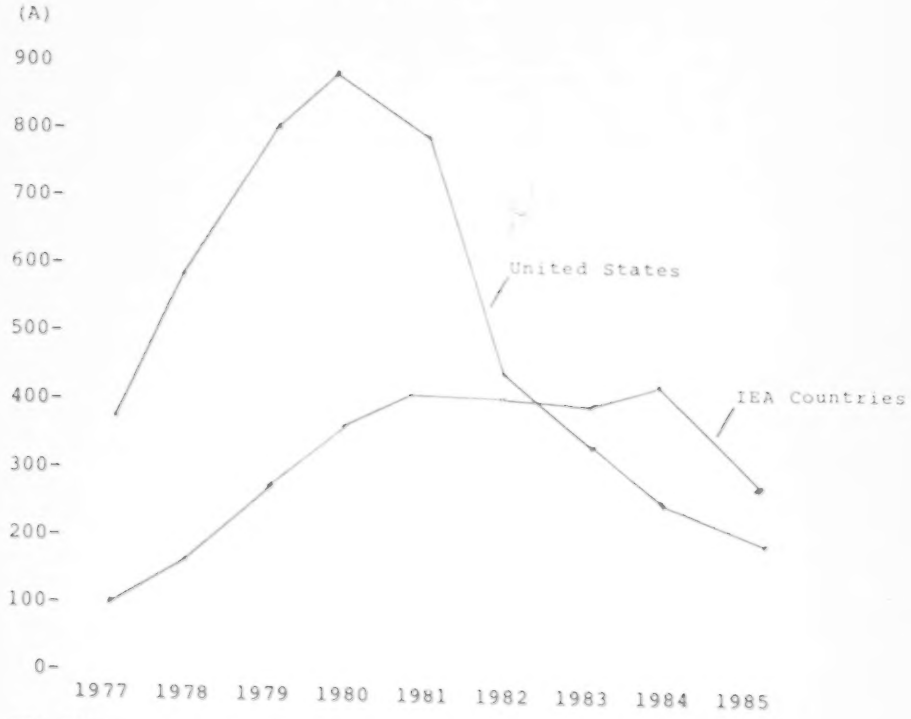
CONCLUSION

The legislative initiatives outlined in S.1320 and S.1554 will seriously help the U.S. industry meet our competitive challenge overseas and maintain a large share of the world market that will grow into billions of dollars. Efforts to maintain a viable federal R&D program, enhance export assistance through existing export programs, and establish clear goals are desparately needed.

In the absence of a practical national energy policy, this legislation is urgently needed to "kick in" the United States government apparatus so that our domestic renewable energy industries are not out maneuvered or run over by our competition. Our international competitors are salavating over the prospect of coopting the United States' predominance in a range of energy technologies in which most of the world will rely upon in the twenty-first century.

As I have stated in earlier testimonies over the last eight years before Congressional Committees, how ironic would it be during the next energy shortfall, for the U.S. to import the very technologies which we developed and held the technological lead. Do U.S. policymakers have the leadership and fortitude to adopt initiatives to maintain U.S. leadership in the high-technology field of renewable energy? The Congress' actions on these two fine pieces of legislation will surely be the indicator. On behalf of the U.S. renewable energy industries, I urge you to act favorably on S.1320 and S.1554. Thank you.

US/IEA GOVERNMENT R&D BUDGETS FOR RENEWABLES IN 1985
US DOLLARS (1977-1985)

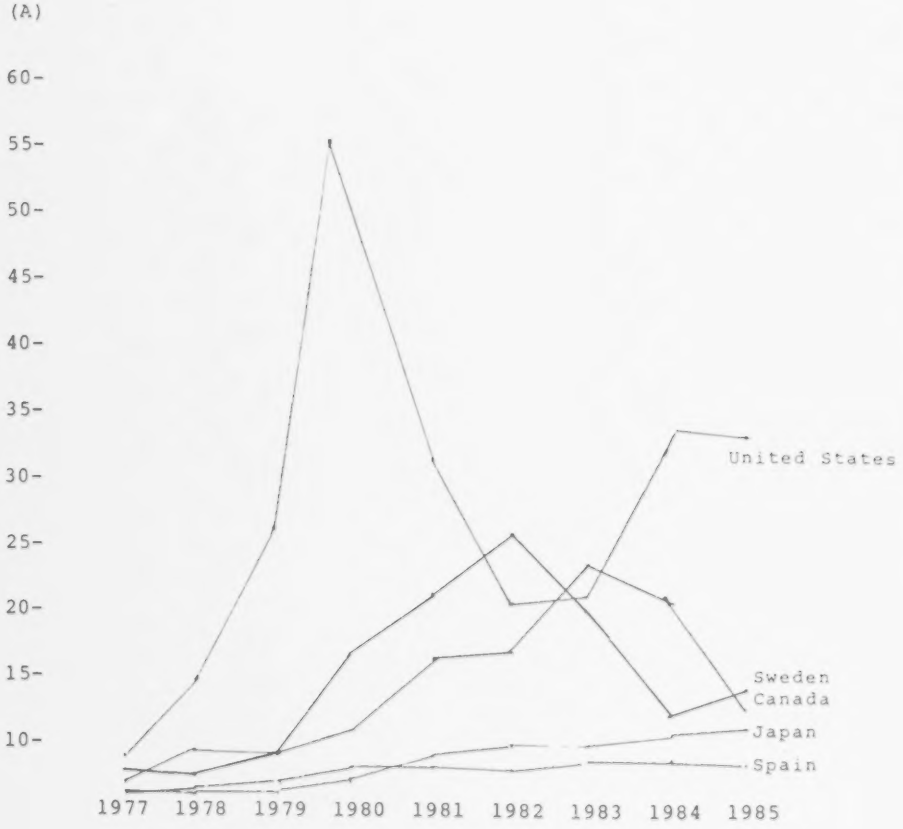


IEA COUNTRIES: Australia, Austria, Belgium, Canada, Denmark, Germany, Greece, Ireland, Italy, Japan, Netherlands, New Zealand, Norway, Portugal, Spain, Sweden, Switzerland, Turkey, United Kingdon

AXIS (A): In millions of U.S. dollars

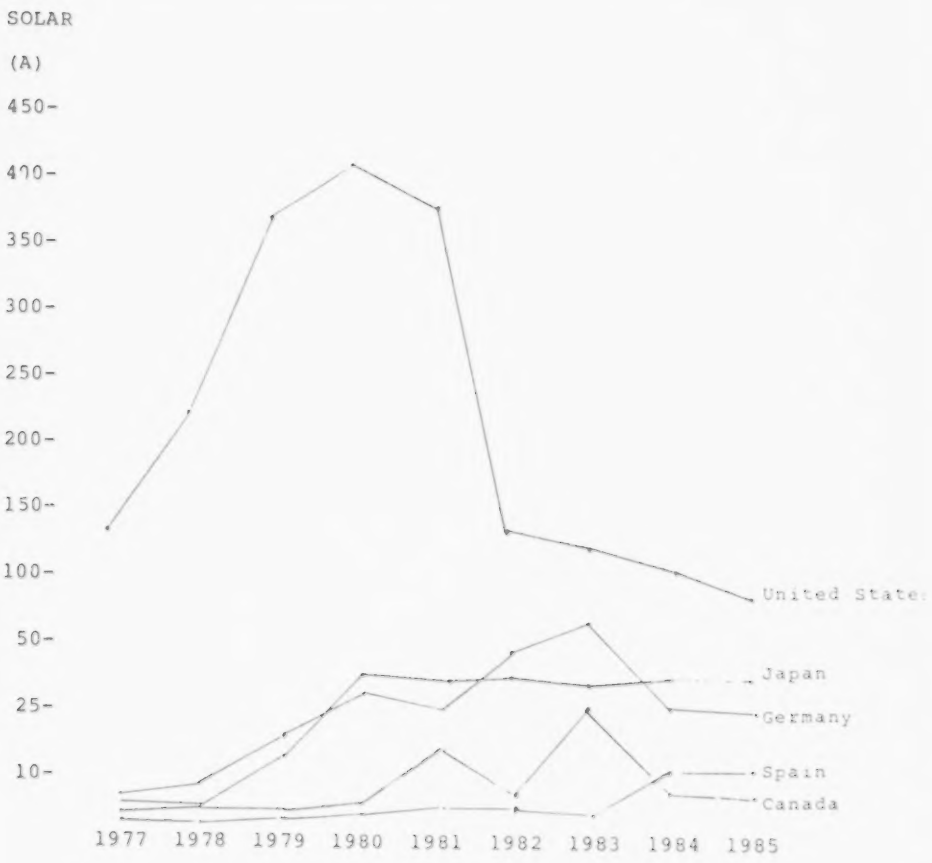
RENEWABLE RESEARCH & DEVELOPMENT SPENDING IN CONSTANT US DOLLARS 1977-1985 IN IEA COUNTRIES

BIOMASS



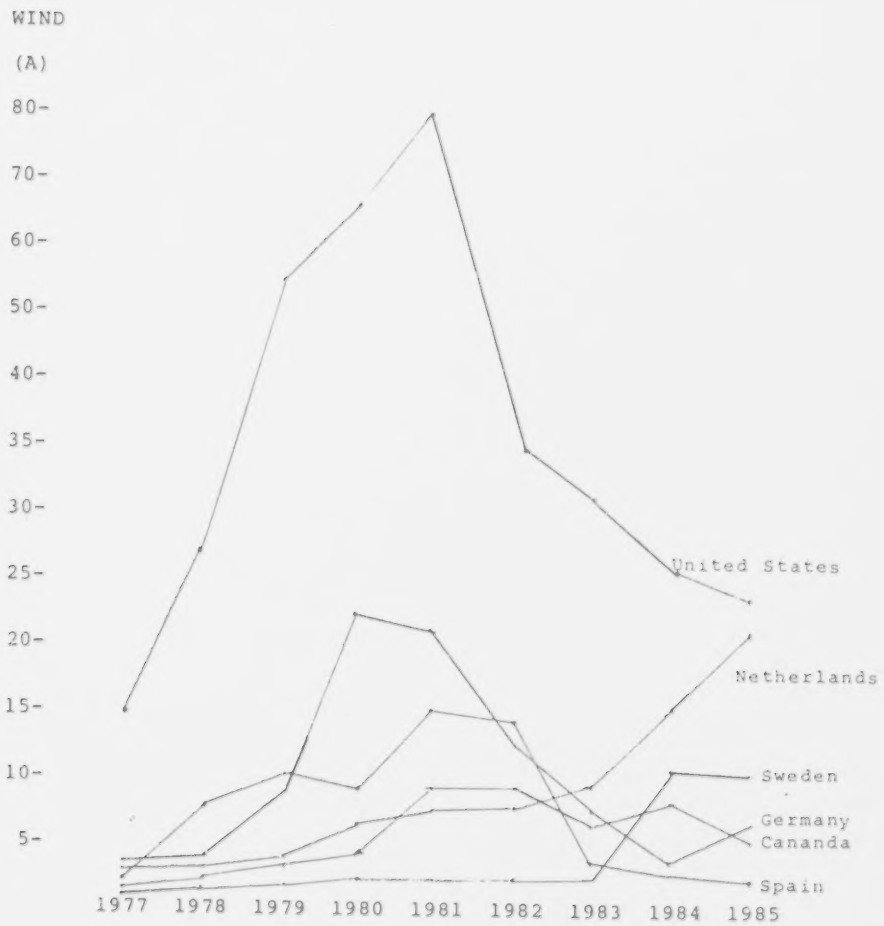
NOTE: A (axis) in millions of dollars (US)

RENEWABLE RESEARCH & DEVELOPMENT SPENDING IN CONSTANT US DOLLARS 1977-1985 IN IEA COUNTRIES



NOTE: A (axis) in millions of dollars (US)

RENEWABLE RESEARCH & DEVELOPMENT SPENDING IN CONSTANT US DOLLARS 1977-1985 IN IEA COUNTRIES



NOTE: A (axis) in millions of dollars (US)

Senator FOWLER. Thank you very much, Mr. Sklar. Mr. Corsi, welcome.

STATEMENT OF JOHN CORSI, PRESIDENT, SOLAREX CORP.

Mr. CORSI. Thank you. I'm John Corsi, president of Solarex, and chairman of the photovoltaics division.

I would like to thank the subcommittee for the opportunity to testify. I strongly support the provisions of bills 1320 and 1554.

Senator FOWLER. Mr. Corsi, excuse me. Let me interrupt you. We do have a vote on. I'm going to run and vote and then Mr. Bumpers and I will be back. But to keep you all from sitting around and waiting for 30 minutes, we go at the same time. Excuse me. I'll be back in a few minutes.

Senator BUMPERS [presiding]. Go ahead, Mr. Corsi.

Mr. CORSI. The purpose of my testimony is to emphasize the importance of the proposed legislation in enhancing the ability of the U.S. PV industry to export its products. There are five essential points that I would like to make.

One, PV is one of the technologies receiving government support that is fulfilling its promise. This has been said several times this afternoon. The cost of photovoltaics has come down dramatically, from about $100 per peak watt in the early 1970's to less than $5 a watt at the current time. This makes photovoltaics the most economical way of generating electricity for many applications today, such as communications, lighting, refrigeration, navigational aids, water pumping, and many others. It is a technology that is economically viable in many many applications today.

The current DOE five year plan is to develop a technology that would reduce the cost of producing photovoltaic modules in large volumes to less than $1 per peak watt by the early 1990's. Most of us agree that this would make photovoltaic-generated electricity competitive with current large scale sources of energy. These goals are entirely consistent with the provisions of bill S. 1554, and I believe they are realistically achievable.

The second point that I would make is that the world market for photovoltaics will reach billions of dollars before the turn of the century. But it has been said that the U.S. industry market share and technical predominance is being eroded, in part because of increasing foreign government support for our international competitors while U.S. government support is being significantly reduced.

The DOE photovoltaic program has been essential to the progress of the industry. But this program has been and continues to be significantly compromised. Congress must recognize the long-range importance that photovoltaics offers this country and assure that a nationally focused effort is sustained, at least at the $45 to $50 million levels that are discussed in the two bills.

I would also like to point out that multi-year funding, as pointed out in bill S. 1320, is very very important to good solid planning within the private industry.

The third point that I would like to make is that in addition to the cost reduction that will be achieved purely through technological progress, the cost of photovoltaics could be further reduced

sooner if we could manufacture at levels that assure economies of scale.

Greater access to two domestic markets—utilities and the U.S. government, particularly the Department of Defense—would accelerate the rate at which costs are being produced. Stronger domestic markets will in fact create a market that is more capable of competing in foreign markets. If we have good markets at home we're going to be more effective competitors overseas.

One program that could in fact help with regard to the utility area is a program called PV-USA. It's a program that we endorse. But unfortunately, at the requested funding level of $7.5 million out of a core photovoltaic budget of $43.1 million, we would have to gut many important core R&D programs to handle this program at that level. We therefore recommend that PV-USA proceed, but proceed at a level that is consistent with the prioritized availability of funds as determined by the DOE, industry, and our national laboratories.

Where the Federal government can provide substantial market pull is by increasing its purchases of solar equipment. We strongly support the provisions of section 6 of bill S. 1320 which require Federal agencies to consider renewables in their overall facilities planning.

The fourth point I would like to make is that photovoltaics is already largely an export industry. According to data from Strategies Unlimited, U.S. industry shipped 6.3 megawatts of photovoltaic products in 1986. Of this, only 2.7 megawatts or 42 percent were installed in the U.S. Strategies further limited worldwide production at 14.5 megawatts, of which only 2.9 megawatts were installed in the U.S. So currently the large markets are beyond our shores.

The fifth point that I would like to make is that the provisions of the bills that enhance the industry's ability to compete in foreign markets are vital. These include continued support for the Committee for Renewable Energy Commerce Trade (CORECT), Export-Import Bank funds to be set aside for renewable energy loans, and resurrection of the OPIC feasibility programs.

In addition, we recommend that these bills earmark at least $10 million of U.S. AID funds for photovoltaics in the developing world during fiscal year 1988.

A couple of concluding comments. Government support will help bring costs down to where the industry can make significant contributions to the nation's future energy problems, and further be an industry that will be a major export industry as well. The Japanese and Europeans recognize these facts and are increasing their support at the same time we're decreasing ours.

So the provisions of this bill with regard to maintaining at least level funding in R&D are very very important. Further, export enhancements with legislative directives and voluntary set-asides are very useful tools to encourage government export assistance in an industry that is already very reliant on export sales.

Finally, I wish to personally thank subcommittee chairman Ford for his support of renewable energy, Senator Bumpers for his foresight in introducing S. 1320, and Senator Fowler for his leadership in solar, and particularly his introduction of bill S. 1554. Thank you.

[The prepared statement of Mr. Corsi follows:]

SOLAREX
Corporation

TESTIMONY

by

John Corsi
President
Solarex Corporation

before

United States Senate
Subcommittee on Energy Research and Development

August 6, 1987

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TESTIMONY ON SENATE BILLS S.1320 AND S.1554

BY JOHN CORSI, PRESIDENT OF SOLAREX AND CHAIRMAN OF THE SEIA PHOTOVOLTAICS DIVISION

I would like to thank the Subcommittee for the opportunity to testify. I strongly support the provisions of Senate Bills S.1320 and S.1554. The purpose of my testimony is to emphasize the importance of the proposed legislation in enhancing the ability of the U.S. PV industry to export its products.

The essential points I will make to members of this Subcommittee are:

- Photovoltaics (PV) is one of the technologies receiving government support that is fulfilling its promise. Costs have been reduced twenty-fold in the last ten years, principally because of the progress the U.S. PV industry has made in conjunction with the Department of Energy (DOE). The future goals established in Bill S.1554 are consistent with this progress and are realistically attainable.

- The world market for photovoltaics will reach billions of dollars before the turn of the century, but the U.S. industry's market share and technical predominance is being eroded, in part, because of increasing foreign government support for our international competitors while U.S. government support is being significantly reduced. The DOE photovoltaic R&D program has been essential to the progress of the industry. This program has been and continues to be significantly compromised. The Congress must recognize the long-range importance that photovoltaics offer this country and assure that a nationally focused effort is sustained, at least at levels suggested in the two Bills. Multi-year funding to allow effective planning and stability is a particularly important aspect of these Bills.

- In addition to cost reduction that will be achieved purely through technological progress, the cost of photovoltaics could be further reduced, sooner, if we could manufacture at levels that would assure economies of scale. Greater access to two domestic markets; utilities and the U.S. government, particularly the Department of Defense (DOD); would accelerate the rate at which costs are being reduced. Stronger domestic markets help create an industry that is more capable of competing in foreign markets.

- Photovoltaics is largely an export industry. According to data from Strategies Unlimited, U.S. industry shipped 6.3 MW's of photovoltaic products in 1986. Of this only 2.7 MW's

or 42 percent were installed in the U.S. Strategies Unlimited listed world-wide production at 14.5 MW's of which 2.9 MW's or 20 percent were installed in the U.S. Currently the large markets are "out there."

- The provisions of the Bills that enhance the industry's ability to compete in foreign markets are vital. These include continued support for the Committee for Renewable Energy Commerce Trade (CORECT), Export-Import Bank funds to be set aside for renewable energy loans and resurrection of the OPIC feasibility program.

PHOTOVOLTAIC TECHNOLOGY

Photovoltaics, or solar cells, are high-technology semiconductor devices that transform light directly into electricity. Solar cells have been used in space for over two decades for the powering of most communication and military satellites. In the mid-70's a serious effort began to modify the space-based PV technology so that it could be used as a competitor to large-scale electricity sources such as coal, oil, natural gas, and nuclear. This ambitious undertaking has been powered in large part by the ongoing commitment of the U.S government via research done or funded by the U.S. DOE.

The main effort has been to take the proven PV technology used in space and lower its cost so that it can be competitive on earth. Crystalline silicon is the workhorse of the PV effort. In the last decade, great advances have been made. Silicon devices that convert more than 20 percent of incident sunlight into electricity have been demonstrated, and crystalline silicon cells show rock-stable performance over long durations and under stressed conditions. Work continues in developing new methods of further reducing material and processing costs. The federal effort emphasizes fundamental studies (material properties, advanced growth methods, etc.) that supplement the ongoing efforts being carried out by industrial R&D teams.

Research effort is increasingly concentrating on thin film PV cells which are several orders of magnitude more light absorbing than previously used materials. Thus the thickness of a solar cell using the new materials can be reduced about 100-300 fold in comparison with earlier designs. This affects both material costs and processing costs, since thinner cells require significantly less material and can be made much faster. Not enough can be said for the critical role of the DOE program in initiating and supporting the new technologies. Progress is steady but depends, in part, on continued federal R&D support.

This R&D activity has driven the cost of producing photovoltaic modules from $100 per peak watt 10 or 15 years ago to approximately $5 per peak watt today. This makes photovoltaics the most economical way of generating electricity for many applications such as communications, lighting, refrigeration, navigational aids, water

pumping, etc. where conventionally generated electricity is not immediately accessible.

The goal of the current DOE five-year plan is to develop technology that would reduce the cost of producing photovoltaic modules in large volumes to less than $1 per peak watt by the early 1990's. Most industry, academic and government experts agree that this could make photovoltaic generated electricity competitive with current, large-scale sources of energy. These goals are consistent with the provisions of Bill S.1554 and are realistically achievable.

FEDERAL BUDGET

Progress has taken place despite a climate of lean and diminishing budget support. There is evidently a critical gap between the intentions of PV scientists and the thinking of public decision makers who formulate our national budgetary priorities. Since 1982, the federal PV budget has gone from $150 million annually to under $50 million. The PV budgets of other industrial countries have increased steadily. The per capita budgets of Japan and the European Economic Community now surpass ours.

The OMB budget request for fiscal year 1988 for photovoltaic energy systems is $20.6 million, a $26.5 million decrease from the 1986 adjusted appropriation. The DOE Five-Year Research Plan, initiated in 1983, was developed on the basis of a budget of approximately $60 million per year, which has been more than matched by industrial research funding. Progress toward establishing the technology base necessary for large-scale commercialization of photovoltaics has actually been made at lower levels of funding (about $40-50 million per year). Because most programs have already been substantially reduced, further budget cuts would force cancellation of some promising programs in order to sustain a critical mass effort in the surviving programs. It could also result in dissolving some of the infrastructure that is important to a continued, first-class effort in PV research.

The U.S. has begun to lose its dominant position in a potential multibillion dollar world market to the Japanese. In fact, certain studies show that Japan has already surpassed the U.S. in selected segments of the PV market.

The following chart outlines the funding levels of the photovoltaics program over the last two years and our industry recommendations for each of the programs:

PHOTOVOLTAIC ENERGY SYSTEMS: U.S.-DOE BUDGET SUMMARY
(MILLIONS OF DOLLARS)

PROGRAM	FY 86	FY 87	FY 88 INDUSTRY RECOMMENDATIONS
MATERIAL RESEARCH			
1. Amorphous Silicon Thin Films	10.0		9.5
2. Thin Films	7.5		8.5
3. High Efficiency Research	7.5		7.7
4. PV Fundamental Research	4.0		4.0
COLLECTOR RESEARCH	9.6		10.0
TECHNOLOGY DIFFUSION	2.1		2.0
CAPITAL EQUIPMENT	1.2		1.4
CORE PROGRAMS	$41.9	$40.4	$43.1

Any reduction in the core program would require the elimination, not just the reduction, of programs which could and likely would impede our progress toward the $1 per watt goal.

Further, we strongly recommend that the allocation of funds and priorities for their use be done under the direction of the DOE working in conjunction with the national laboratories and industry. There has been repeated attempts to influence the allocation of funds through processes that are purely political and which may have little to do with their importance to U.S. competitiveness.

DOMESTIC MARKETS

Utilities

Utilities offer the U.S. PV industry enormous market potential. If this potential is realized, cost reduction of photovoltaics can be accelerated through investments in plants of sufficient size to achieve economies of scale.

In turn the utilities and the nation will benefit. Photovoltaics uses sunlight to produce electricity and is therefore based on an inexhaustible, clean source. There is no fuel-burning and no pollution. There is no expended fuel to dispose of, no environmental poison or radioactive waste. Photovoltaic generating capacity can be added in increments rather than in huge 1,000 megawatt plants. This reduces the risks associated with long-term utility planning. Recent studies of existing megawatt PV demonstration projects show that PV electric generation is perfectly matched with summer peak load demand for air-conditioning. This makes the incremental addition of PV more valuable because it reduces the need for extra baseload generation. These projects have also demonstrated solid reliability and maintenance-free operation.

A recent U.S. government sponsored report by the Renewable Energy Institute, entitled Utility Decision Making in the 1980's: Implications for Renewable Energy, points to obstacles to further progress in this market. Some of their conclusions:

> "The positive attributes of renewable energy are outweighed by perceived technical and economic risks associates with their current level of development in the utility sector. From a technology standpoint, utilities are looking for reliable power sources with extensive performance records demonstrated in a similar utility operating environment.
>
> It is generally felt by utilities that government, utilities and vendors all have a role in technology development, but that these roles need to be well-coordinated for a new energy technology to reach maturity. Utilities felt that for renewable energy technologies (RETs) to reach commercial maturity, the relationship of the three groups must be modified, including reestablishment of government participation in technology demonstration. . . ."

PV USA is one program that addresses all of these issues and could provide the impetus that we seek in this marketplace. Unfortunately, funding it at the requested level of $7.5 million within the core budget of $43.1 million would require dismantling ongoing, critical technology programs which we feel must be protected. We, therefore, recommend that the PV USA program be conducted under the direction of the DOE's Office of Photovoltaic Energy Systems at a level that is consistent with availability of funds.

U.S. Government

The federal government can provide substantial market pull by increasing its purchases of solar equipment.

For example, in 1982 Congress directed the Department of Defense to procure renewable energy devices when cost effective. The Defense Department is the largest owner and constructor of buildings in the world and is one of the largest customers for remote electric power. As a result of the legislation and interaction with SEIA, the Department has instituted a tri-service panel on photovoltaics, and has published a report outlining their experience with renewable energy. Progress has been made but has been painfully slow relative to the potential gains. SEIA has asked for hearings before the House Armed Services Committee to spur Defense Department purchases by streamlining the procurement process, modifying the "cost effective" requirements, and educating local base commanders and procurement officers.

Second, the U.S. Congress is spending billions of dollars to make our embassies less susceptible to terrorism. In 1986, the GAO reported that over 85 percent of our overseas embassies and military bases rely on the local utility grid. Renewable energy devices can produce and store energy on-site, providing these facilities with access to energy at all times. This can be a significant aspect of assuring security and represents an extraordinary market opportunity for the renewable energy industry.

We strongly support the provisions of Section 6, Federal Procurement, of S.1320 which requires Federal agencies to consider renewables in their overall facilities planning.

EXPORT MARKET

In addition to being a promising source of future electricity for our domestic needs, PV represents a strong potential U.S. export. About 75 percent of the world is without grid electricity, and there are some two million villages within 20 degrees latitude of the equator that have no electricity. Photovoltaics and other renewable energy technologies are uniquely suited to most of the requirements of third world nations: technolgies use indigenous resources, can be purchased in small, more affordable increments, and can be easily assembled and maintained in the host country. PV is already replacing diesel-generated electricity in rural markets. Long before we make PV commercial in the U.S. utility market, it will be far and away the best means of generating electricity in the Third World. Since over half the peoples on earth do not have access to electricity, the market potential for photovoltaics and renewable resources are astounding. This huge export market will be tapped by the global leaders in photovoltaics.

LEGISLATIVE INITIATIONS TO SUPPORT EXPORTS

The Committee for Renewable Energy Commerce Trade (CORECT) has been valuable in assisting the solar industry in its export activities. It has played a key role in reaching and educating organizations

that are vital to funding of projects in developing nations, such as OAS and the The World Bank. As a result of their efforts and continuing efforts on the part of industry, some of the previous obstacles to greater use of photovoltaics in developing nations such as lack of knowledge, skepticism about its viability, concern about cost effectivity, etc. are being rapidly eroded.

One of the major obstacles that remains is the lack of an infrastructure that aligns available funds with deserving projects. Many of the agencies that provide funding for developing nations are geared to multimillion or even multibillion dollar projects. The typical photovoltaic project is measured in tens or perhaps hundreds of thousands of dollars. The CORECT efforts can be significantly strengthened if organizations that have funds to support energy projects are given greater authority and direction in allocating some of those funds to renewable energy projects. This will help develop the infrastructure that is necessary to deal with multiple small projects.

The provision of Bill S.1320 that sets aside a specific part of the loan authority of the Eximbank for solar and renewable energy loans will greatly enhance the effectivity of CORECT. The resurrection of the OPIC feasibility program will have a similar impact.

The Agency for International Development has funded important projects including a renewable energy data base and recently, a manual on renewable energy technologies for rural irrigation. While the Agency for International Development has supported our industry in both the letter and spirit of the law, we would also recommend that these Bills earmark at least $10 million of their funds for photovoltaics projects in the developing world during FY 1988.

CONCLUSION

As an industry we have made tremendous technological progress resulting in exponential reduction in costs and an every increasing market base. The technology is proven and cost effective for a broad array of applications. However, the current market size relative to the level of R&D expenditures required to penetrate even larger markets, such as utilities, is such that the industry is not self-sufficient (i.e. profit margins are not sufficient to fund R&D).

Government support will help bring costs down to the point where the industry can make significant contributions to this nation's future energy problems and be an industry that will have major export markets as well. The Japanese and Europeans recognize these facts and are increasing their support at the same time that the U.S. is decreasing theirs.

Level and slight increases in photovoltaics and renewable energy R&D are necessary and imperative. The R&D sections of both bills must be enacted in this regard.

Export enhancement with legislative directives and voluntary set-asides are very useful tools to encourage government export assistance in an industry very reliant on export sales.

I personally wish to thank Subcommittee Chairman Wendell Ford for his support of renewable energy, Senator Dale Bumpers for his foresight in introducing S.1320 which is essential to the growth of the photovoltaic industry, and Senator Wyche Fowler, whose leadership in solar is well known and whose bill, S.1554 establishes the kind of legislation needed to promote an important U.S. energy industry.

Senator BUMPERS. Thank you. Ms. Walden.

STATEMENT OF OMI WALDEN, WALDEN ASSOCIATES, ON BEHALF OF THE SHEETMETAL WORKERS' INTERNATIONAL ASSOCIATION

Ms. Walden. Thank you, Mr. Chairman.

On behalf of the Sheetmetal Workers' International Association, I really do appreciate the opportunity to comment on these two pieces of legislation. We commend the sponsors of these bills for recognizing the need to refocus the nation's agenda on the development of commercialization of both energy conserving and renewable energy-based technologies. We also look forward to working with you and your staffs on improving these measures as they go through the legislative process.

Senator BUMPERS. Ms. Walden, would you pull that microphone up closer? These things are only effective if you get right in there.

Ms. WALDEN. Sure.

One might ask what specifically the interest of the Sheetmetal Workers' International Association is. For those of you who may not know, it is one of the largest, and I believe, one of the most progressive of our construction trade unions. First, and I guess simply to say, we have a great belief that what is good for America is good for sheetmetal workers.

But more importantly, they have a concern about the world energy needs and the role that this country is going to play in meeting those needs. They have a tremendous interest in their own job security. They believe the best way to insure job security is to insure the creation of new and continuing sources of jobs.

They believe that based on studies that they have been doing since the early 1970's that both energy conserving technologies and renewable-based technologies provide two of the best opportunities for them to do so. They have taken their own resources in recent years and established a number of what I consider to be very progressive initiatives.

First, they established a trust fund which now has an annual budget of over $2 million to train their people in energy management and conserving technologies. They have established a trust fund that requires for commercial construction the inclusion from the design point forward the incorporation of solar thermal technologies.

But perhaps I think the most exciting thing they have done is to utilize the resources of their national pension fund to invest in the photovoltaic industry. They recently made a commitment of $15 million for an equity position in the Chronar Corporation. They did this because first of all, they believe it to be a prudent investment of their pension fund resources.

But more importantly perhaps in terms of the creation of jobs is their belief that it is a far-reaching and revolutionary technology that has applications not only in the energy field but in many other areas of equal importance.

They have also made a commitment to participate with Chronar Corporation in the establishment of what will be Chronar's sixth manufacturing facility. That will be the largest photovoltaic manu-

facturing facility in the world. We are presently looking for a site location for that facility, and we expect to have it in operation by the end of 1988. It will have a production capacity eventually of ten megawatts.

The product produced in that facility will be geared toward the utility sector and the commercial and industrial industry. We think that that has significant ramifications for the industry itself, and has tremendous potential in terms of the creation of jobs for this particular construction trade and others.

At the risk of seeming somewhat immodest, I would consider these decisions to represent very bold and progressive and foresighted leadership on the part of the sheet metal industry. I believe the venture represents the best in leadership and cooperation between labor, management, and private industry. It is the kind of leadership that is absolutely vital if the U.S. photovoltaic industry is to maintain a competitive position with Japanese manufacturers and other international competitors.

But the private sector cannot do it alone. We really do need more aggressive leadership from the Congress and the Administration. There must be a multi-year commitment that marshals both public and private resources if we are to be the world leader in the development, production, and marketing of photovoltaics.

Because of its potential, we are of the opinion that photovoltaics need to be distinguished from other solar technologies and given the national attention, focus, and priority that it merits. It is time for the Congress, the Administration, private industry, and most importantly, private capital markets to wake up, to take notice, and most importantly, to take the actions that we believe are necessary immediately if we are to recapture the number one position in the marketing of photovoltaic products and systems. We have created this technology in the United States. It comes out of the NASA program. It was one that we put on the leading edge. It was one that I believe the scientific community and others related and closely involved with the program believed at the time that DOE took it over to be really one of the best managed Federal programs in the entire system.

We believed it to have very sound technical and cost reduction targets. I think the staff of DOE, SIRI, and the other labs are really to be commended for their diligence in sticking with the multi-year program, even while their very foundation in terms of funding has been whittled away.

Senator BUMPERS. Ms. Walden, I've got to go. But I want to tell you, if you want to put that plant in Arkansas, I'll promise you more funding for photovoltaic research.

Ms. WALDEN. I'll see you right after I finish.

But we've watched the Federal funding for photovoltaics drop from $60 million down to less than $40 million. I understand from conversations with DOE staff people today that as of yesterday they were working on additional directives to cut the funding further.

Gentlemen, this simply won't get the job done. I know it's really not popular in today's deficit environment to talk about coming before the Congress to ask for additional increases in R&D funding or any type of funding. But if we're serious about this technology,

if we have the will to win, we can elect to be number one again. The question is simply whether or not we're going to elect to do it, whether we're going to elect to do it in a timeframe that allows us to win.

The program has experienced really phenomenal success. The Chronar plant for which we are presently seeking the site will produce photovoltaics at a direct manufacturing cost of 60 cents per watt, which will allow for an installed cost of between $2 and $3 per peak watt, or approximately ten cents per kilowatt hour. Already they are prepared to take orders for utility applications in the order of 100 megawatts or larger.

This price decline we expect to continue further. We predict that prices for PV panels made with this technology will eventually reach those of a similar industry, that of heat reflecting glass. This type of glass which is coated with thin layers of reflective material in a comparable process costs around $10 per square meter, which is equivalent to a price of 20 cents per watt for a panel with an efficiency of five percent, and 10 cents per watt for a panel with an efficiency of ten percent.

With these projected decreases in cost for photovoltaics, the market demand for the project will also grow accordingly. As they become increasingly competitive with other electrical power sources as the cost does decline, the worldwide market is also going to increase considerably. Experts predict that the market for photovoltaics will reach one gigawatt during the 1990's. At an average installed price of $2 per watt, industry-wide revenues could theoretically reach as much as $2 trillion.

The possibilities really are tremendous. But astonishingly, it seems to us that no one really seems to be paying attention. Pardon the cliche, but it seems appropriate to us to say that the driver, with the exception of a few in Congress, that the Congress and the Administration is asleep at the wheel.

The word "photovoltaics" would soon be as common as transistor and laser, but most non-physicists are today unfamiliar with the technology. The situation is further exacerbated by the label "solar" and its identification with the lower tech solar thermal applications.

While we fully support all of the renewable-based technologies, we think we are making a drastic and irreversible mistake if as a nation we do not soon recognize photovoltaics as an advanced technology with virtually unlimited applications, and give it the thrust of leadership and financial support that it merits.

Unfortunately, we do not have a monopoly on this technology. In 1977 Japan's Ministry of Trade and Industry (MITI), which is the group that organized Japan's development of a world-class microelectronics industry, announced that it would begin a government coordinated effort to find commercial applications for photovoltaics.

Make no mistake—focusing on the combined power of the Japanese government, financial and industrial resources, it is a momentum that should not be taken lightly.

The sheet metal industry believes that the leaders of this country cannot afford to continue to give lip service to the photovoltaic industry, particularly when the Japanese and other international competitors have targeted it for industrial supremacy. While we

fully support Senate bill 1320 and Senate bill 1554, I must say that we believe that significant efforts must be applied to strengthen these initiatives if they are going to be truly effective in the timeframe that is required.

We look forward to working with you to do those things. We have looked at how we might improve the legislation without looking at the specifics of it. We have arrived at a program that would involve at least nine major points.

Most importantly, a multi-year funding commitment to research and development, and at a level that is sufficient to make the difference and make the contribution within the timeframe we are talking about. We believe that it can be no less than $50 million. It is a fairly well-known fact within scientific communities that for every one dollar invested in basic research and development, it takes ten dollars for product and process development, and one hundred dollars for commercialization.

We're nowhere near that. We've come from 60 to 40 and we've reduced the certainty and we have riddled the budget with special interest projects. We need a cooperative research and development effort that clearly sends the signals to the private sector and to the public sector that we have made this a national priority.

We need a program that clearly defines the role of government to be research and development and that leaves the commercialization of products and systems utilizing the photovoltaic technology to the industry. Specifically, it should be recognized that Federally-funded demonstrations do not for the greater part help, and can be detrimental to a technology that is advancing as rapidly as photovoltaics.

We need a program that recognizes and addresses the need to reduce the financial burden on the photovoltaic industry during the applied research process or product development phase of the industry. We need a program that exhibits the will to win by not encouraging our other Federally-funded agencies and organizations to use photovoltaics, but mandates that they meet aggressive targets in the purchase of these systems.

We need a program that places the highest priority on the research and development of applications in the military, the utilities sector, and the residential, commercial and industrial sector. As I said earlier, the plant that we hope to have in operation by the end of 1988, the entire product line is going to be geared toward the utility sector and the industrial commercial sector.

The utility sector is one that needs particular care and attention. It's one that we can track. We know what the needs are going to be in the mid-1990's and toward the year 2000. We know that we do not have the capacity out there to meet the peak power needs.

It is one that we could work closely with the government and the utility industry and lay out a well planned reasonable plan that could be met. We need a program that most importantly assures the formulation of capital in the private sector. We have eliminated most of the subsidies, most of the funding for the program. We have eliminated the signal to the private sector that this is a long-term process but this is a viable technology, one that is cost competitive and one for which the market is there.

We desperately need that signal to be sent to the capital markets. There are numerous mechanisms by which we can do that. I believe that we could learn from some of our international competitors.

Again, I appreciate the opportunity to be here today on behalf of the sheet metal workers. We are in full support of all energy conserving and renewable-based technologies. We believe that we have a winner here. We would like to see the leadership and the financial commitment to make it happen. Thank you.

[The prepared statement of Ms. Walden follows:]

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TESTIMONY

By

Omi G. Walden

On Behalf of

The Sheetmetal Workers' International Association, AFL-CIO

Before

Senate Energy and Natural Resources Committee
Subcommittee on Energy Research and Development

August 6, 1987
Washington, D. C.

On behalf of the Sheet Metal Workers International Association, AFL-CIO, I appreciate the opportunity to comment on the Solar Development Initiatives Act of 1987 (S. 1320) and the Renewable Energy and Energy Conservation Technology Competitiveness Act of 1987 (S. 1554). We commend the sponsors of these bills for recognizing the need to refocus the Nation's agenda for the development and commercialization of energy-conserving and renewable-energy technologies. We also look forward to working with you to strengthen these measures as they move through the legislative process.

What specifically is the interest of the Sheet Metal Workers in the development and commercialization of such technologies? A quick and simple answer -- What is good for the country is good for Sheet Metal Workers. First, we believe it is foolhardy for the world's leading free nation to be overly dependent upon one energy resource and to have our economy and our national security vulnerable to interruptions in its production and delivery. Secondly, we believe that energy-conserving and renewable-energy technologies offer virtually unlimited potential for producing environmentally safe, technically reliable, and cost-competitive supplies of energy. Thirdly, the 150,000 laborers who are members of the Sheet Metal Workers' International Association and their employers have the skills necessary to manufacture, install and maintain many of the systems or applications resulting from the successful development of these technologies. Thus, the jobs potential gives us a keen interest in making certain that the federal role in the development and deployment of these technologies is adequately defined and executed.

As Sheet Metal Workers we are the primary trade involved in the manufacture, installation and maintenance of heating, ventilation and air conditioning systems. Shortly after the oil embargo, we contracted individually with MITRE, Standford Research Institute and Syracuse University to assess the jobs potential for our Industry within the energy field. The conclusions of each study were similar and to the point. Turn to the energy management services field and the commercialization of solar energy technologies. We have done exactly that.

In 1981 we, in cooperation with our Contractors, established the National Energy Management Institute as a nonprofit organization to train our people and to promote job development in the energy management services area. To date some 2,000 technicians and 500 contractors have been trained and certified to perform energy audits and energy-efficient retrofits of

existing facilities. While we have received over $2.5 million in federal and state grants, we recognized the need very early to provide a permanent funding vehicle for this most important program. Consequently, we established a trust fund that is supported by employer contributions. For each hour that a Sheet Metal laborer works the employer contributes 2 cents. This generates on an annual basis over $2 million to fund the training of technicians and contractors and to promote the merits of energy management services to building owners and managers.

Likewise, we have aggressively pursued the jobs potential of solar-powered technologies. With the support of a DOE grant we developed and integrated into our nationwide apprentice training program a curriculum on the installation and maintenance of solar thermal systems. To stimulate the marketplace our National Pension Fund has created a separate and distinct Trust Fund to provide financing for new construction and incorporate solar energy systems that will produce at a minimum 75 percent of the building's water heating and 40 percent of the space heating requirements. While these are exciting undertakings, our most progressive action is our recent venture into the U.S. photovoltaic industry.

Utilizing the resources of our National Pension Fund, our Industry invested $15 million in the Chronar Corporation the leading U.S. manufacturer of amorphous silicon panels. Foremost, we believe this to be a prudent investment of our capital. But the most exciting aspect is the technology's potential. Photovoltaic technology can meet a major portion of the world's energy needs resulting in greater national and economic security. It also has exciting and revolutionary applications for other advanced technologies including computer memories. Indeed, we have not truly begun to identify the virtually unlimited variety of applications ranging from consumer products to microelectronics, to transportation, to construction materials, to utility power generation. For Sheet Metal contractors and laborers the production of photovoltaics means the creation of jobs using the products of a technology that is reliable, cost competitive, environmentally safe, and free of known health risks.

In addition to requiring a substantial equity interest in Chronar we are committed to the establishment of Chronar's sixth manufacturing facility. This facility will have a production capacity of 10 megawatts per year and will be the world's largest photovoltaic manufacturing facility. Presently we are seeking a location for this facility and we expect to have it in operation by the end of 1988. The product from this plant will be destined

for utility applications and the commercial and industrial sectors of the construction industry. As an adjunct to the manufacturing plant the Sheet Metal Industry will establish a training facility which will be used for training our people from throughout the country to fabricate, install and service photovoltaic-powered products and systems.

At the risk of seeming immodest, these decisions and actions represent bold, progressive and farsighted leadership on the part of the Sheet Metal Industry. The venture represents the best in leadership and cooperation between labor, management and private industry. It is the kind of leadership that is absolutely vital if the U.S. photovoltaic industry is to maintain a competitive position with Japanese manufacturers. But the private sector cannot do it alone. More aggressive leadership from the Congress and the Administration is desperately needed. There must be a multi-year commitment that marshals our public and private resources if the U.S. is to be the world leader in the development, production and marketing of photovoltaics.

Because of its potential, photovoltaics needs to be distinguished from other solar technologies and given the national attention, focus and priority it merits. It is time for the Congress, the Administration, private industry and private capital markets to wake up, take notice and most importantly take actions immediately to capture this rapidly fleeting opportunity. Both S. 1320 and S. 1554 fall woefully short of providing the leadership, the R&D funding, the effective program approaches, and the incentives to the industry and private financial markets that are necessary in order for the U.S. Photovoltaic Industry to recapture its number one position in the world market. For these reasons we have elected not to comment in a direct manner on many of the specifics of S. 1320 and S. 1554, but rather to assess where we have been, where we are, and what we should do as a Nation to seize the opportunities which this technology presents.

The U.S. created the photovoltaic technology and we dominated the world market until recently -- a market that we can elect to dominate again. It came out of the NASA space program which, needless to say, is the classic example of where our Nation's leaders had the will to win and marshalled our resources to do so.

When the photovoltaic program came under the auspices of the U.S. Department of Energy (DOE) many within the scientific community and elsewhere considered it to be one of the best planned and managed federal research and development efforts. We are indeed fortunate that the staff has exercised a determination

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to maintain a technically sound multi-year R&D program, albeit their foundation in recent years has been substantially chiseled from underneath them.

In 1982 the federal research and development budget was some $60 million. It has been cut to $40 million and as we sit here today the DOE, SERI and various lab staffs are working on further budget cutting directives. While the deficit of this Nation is ludicrous, so is the lack of foresight and will to reorder priorities and to provide the funding increases necessary to bring the photovoltaic technology into broad use.

The $60 million level of funding was barely adequate to establish a viable cost-shared core research and development effort. There seems to be a belief throughout the photovoltaic industry and related circles that the best that can be hoped for is to hold the erosion at the $40 million level and stave off further attempts to line item special interest projects. In this deficit environment this may be the political reality. But let us not deceive ourselves -- $40 million will not get the job done. It simply hands the technology and the market to the Japanese with a little grace.

Where is our will to win? This Nation put over $100 billion into the development of the microelectronics industry and we provided over $150 billion in subsidies to the oil industry. This is not to imply that the same amounts are needed to bring photovoltaics to fruition, but simply to drive home the point that we need to be realistic.

It is widely recognized within industry and I believe David Sarnoff, the genius behind color television, should be credited with the assessment that for every $1 invested in research and development $10 is required for process development and $100 for commercialization. Thus, the need to reorder priorities and marshal public and private resources behind the technology that offers the most far-reaching potential seems clear and to us is urgent.

Phenomenal success and progress is being accomplished in the development of photovoltaics in large part due to: 1.) the implementation of a realistic technical plan based on sound technical and cost-reduction targets, 2.) the participation of competent industrial organizations capable of conducting multidisciplinary research, 3.) multi-year funding to allow for systematic research programs and the development of confidence in industrial teams, and 4.) the leveraging of government and industry resources through the cost sharing of research.

The Chronar plant, for which we are presently seeking a site, will produce photovoltaics at a direct manufacturing cost of $.60 per watt which will allow for an installed cost of between $2.00 and $3.00 per peak watt or approximately $.10 per kwh. Already Chronar is prepared to take orders for utility systems of 100 megawatts and larger.

This price decline is expected to continue. Chronar predicts that prices for PV panels made with its technology will eventually reach those of a similar industry, that of heat reflecting glass. This type of glass which is coated with thin layers of reflective material in a comparable process, costs around $10.00 per square meter, which is equivalent to a price of $.20 per watt for a panel with an efficiency of 5% and $.10 per watt for a panel of 10% efficiency.

With the projected decrease in cost for photovoltaics, the market demand for this project will grow accordingly. Not only will photovoltaics become increasingly competitive with other electrical power sources as the cost of photovoltaics declines and the cost of traditional energy rises, but overall worldwide demand for electricity is expected to increase at a faster rate than the overall demand growth of energy. Experts predict that the market for photovoltaics will reach one gigawatt (one billion watts) in the 1990s. At an average installed price $2.00 per watt industry wide revenues of $2,000,000,000 are projected.

The possibilities are tremendous, but astonishingly no one in the U.S. seems to be paying attention. Pardon the cliche, but it seems appropriate to say "The driver -- the Congress and the Administration -- is asleep at the wheel."

The word "photovoltaics" will soon be as common as the words "transistor" and "laser". But most nonphysicists are today unfamiliar with the technology. And the situation is further exacerbated by the label "solar" and its identification with the low-tech solar thermal applications. We will make a drastic and irreversible mistake if as a Nation we do not soon recognize photovoltaics as an advanced technology with virtually unlimited applications and give it the thrust of leadership and financial support it merits.

Unfortunately, the U.S. does not have a monopoly on this technology. Indeed, we have already lost to the Japanese our number one position in the production of commercially viable products that incorporate this technology. The U.S. photovoltaic industry held 80 percent of the world market just a few years

ago. Today, the Industry has barely one-half the market while the Japanese are reaching for world dominance in the technology.

In 1977 Japan's Ministry of Trade and Industry (MITI), which organized Japan's successful development of a world class microelectronics industry, announced that it would begin a government-coordinated effort to find commercial applications for photovoltaics. Make no mistake, focusing the combined power of Japan's government, financial and industrial resources on photovoltaics represents an extraordinary challenge the ramifications of which we as a Nation have thus far failed to comprehend.

The Sheet Metal Industry believes that the leaders of this country cannot afford to give lip service to the photovoltaic industry when the Japanese have targeted it for industrial supremacy.

S. 1320 and S. 1554 must be strengthened to provide the national initiative necessary to marshal and focus with a sense of urgency the resources of government and industry. We must commit our resources to a multi-year, goal-oriented program that will enable the U.S. photovoltaic industry to recapture and maintain the number one position in the production and marketing of products that incorporate photovoltaic technology. To accomplish this we consider the following elements to be essential to sound legislation:

1.) A multi-year funding commitment to a research and development program that is cost-shared with the photovoltaic industry and other key players including the design and construction industry, microelectronics industry and the utility sector;

2.) A commitment to increase federal funding of research and development to an initial base level of $50 million in order to bring the potential of the photovoltaic technology to fruition within a time frame that will enable the U.S. Photovoltaic Industry to secure the number one position in the marketplace;

3.) A cooperative research and development program that has the national priority to capture the interest, expertise and financial resources of the government, academic and scientific institutions, industry, and private financial

markets;

4.) A program that clearly defines the role of government to be research and development and that leaves the commercialization of products and systems utilizing photovoltaic technology to the Industry. Specifically it should be recognized that federally funded demonstrations do not help and can be detrimental to a technology that is advancing as rapidly as photovoltaics;

5.) A program that recognizes and addresses the need to reduce the financial burden on the photovoltaic industry for the applied research and development necessary to achieve efficiencies in the production of photovoltaics, as well as the manufacture of products and systems incorporating photovoltaic technology;

6.) A program that exhibits the will to win by mandating that all federal agencies and other federally funded organizations meet aggressive targets on actions resulting in purchases of photovoltaic-powered products and systems;

7.) A program that places the highest priority on the research and development and use of applications of photovoltaic technology for the military, the utility sector, and the residential, commercial and industrial sectors of the construction industry;

8.) A program that provides financing mechanisms and incentives to the utility sector to install 100 megawatt and larger photovoltaic-powered systems; and

9.) A program that will ensure the formulation of capital in the private markets necessary to finance the growth of the U.S. Photovoltaic Industry. Such an initiative should be designed to mitigate the financing mechanisms used by MITI and the Bank of Japan to ensure the growth of the Japanese photovoltaic industry.

As a Nation we should elevate the research, development and deployment of the photovoltaic technology to a priority that

equals its potential benefits. We urge you to call for a White House conference and the establishment of a National Commission on Photovoltaics Research and Applications to bring together the Nation's leading scientists, engineers, architects, photovoltaic producers, and financiers to assess the state of America's research efforts and the capital needs of the photovoltaic industry and to report to the President and the Congress actions to ensure that the U.S. Photovoltaic Industry is the world leader in the production of photovoltaic-powered products for commercial, utility and national defense applications.

May I remind you once more and urge you not to stand idly by as Japan reaps the benefits of having targeted another industry for industrial supremacy.

Senator FOWLER [presiding]. Thank you, Ms. Walden. Thank you for your public service under the Carter Administration.

Ms. WALDEN. Thank you.

Senator FOWLER. Mr. Frank Potter, last but not least. He is president of the Renewable Energy Institute in Washington.

STATEMENT OF FRANK M. POTTER, JR., PRESIDENT, RENEWABLE ENERGY INSTITUTE

Mr. POTTER. Senator Fowler, it's a pleasure to be here. It feels a little strange on this side of the witness table, but it's an expanding experience.

You have my statement. I won't repeat it, except to note a suggestion that I made thinking about this. That was that when the legislation is passed, as we all hope it will be, it might be a useful and focusing experience to require the Administration and subsequent Administrations, as they come to grips with these issues and what they propose to do about them, where they elect not to fully fund a program, as they may very well do and in some cases it may be appropriate, they should be required to come to you and say why they didn't.

The discipline of forcing that kind of explanation on a reluctant Administration or Office of Management and Budget might be a salutary experience and might be enlightening for the Congress as well.

Senator FOWLER. Other than budget constraints.

Mr. POTTER. Well, budget constraints—That's part of it certainly. We all have priorities. Sometimes they may seem a little strange, but it's a fact of life.

You asked four questions when you started off, and I would like to just touch on them. The first question was, what do you think Congress should do? And my answer is, I'm afraid Congress has to lead because this Administration simply is not going to.

I have a great deal of respect and admiration for the kind of things that Secretary Martin has been able to do in the year and a half since he has come to DOE. But he is laboring under an enormous burden, not the least of which is that there are what we may say entrenched interests pushing other kinds of activities, other sorts of priorities.

Renewables are new on the scene, they're small, and they don't have much of a cheering section. Not yet. The fact that you have been so involved and so committed to this resource is reassuring. I wish there were more of you. But until that kind of support grows, it's just going to be very hard for an administration to become serious about these issues, as they have to if anything is to happen at all.

Do the bills meet a need that exists out there? They certainly do. What we find ourselves in the position of doing is eating seed corn now that we're going to need at some point in the future—we hope at a comfortable distance in the future, we suspect at a not very comfortable distance in the future.

What are the people going to get from this legislation and when? That's a tough question. Crystal balls are not a precision instru-

ment. It's very clear, as earlier witnesses have testified, that there is enormous vitality and potential in these resources.

We've heard a lot about photovoltaics, and that's a very exciting technology. There are others. You have identified them in your bill. The energy security study said, among other things, that the theoretical potential for contribution of renewable energy in this country is on the order of 80 megawatts. That's more than we use right now. That's a very interesting figure, and I don't know how soft it is. I suspect it's pretty soft. I suspect that in fact the potential may be greater.

Secretary Martin identified a couple of areas of particular interest, one of which is the question of transportation. Certainly that is something that we need to look at very carefully, because when the shoe begins to pinch again, as it will, we know it is going to pinch there hard and painfully.

Renewables do have some potential here, and those potentials should be explored. There is a lot of controversy about the virtues or lack of virtues of ethanol and methanol as fuel sources. I don't know the answers to those questions. I do know that those questions are important and they need to be addressed seriously, more seriously than they have been up until now.

Whether or not it is realistic to say that we can produce "x" quads by the year 1990 or 1992 is awful hard to say. Friends of mine who are in the business of making projections say it is fine to make projections, but if you're going to make projections of numbers you should never use years and if you're going to use years, never use numbers. So I'm not going to get trapped in that.

I want to say finally, Senator, in your exchange with Mr. Martin, I think you hit the thumb squarely on the nail. That is, how do you handle the question of research and development? What is the responsibility of the government? Is it only to do long-term, high risk, high pay-off research? That has certainly been a dominant philosophy for the last several years.

My problem with that philosophy is that that assumes that somebody cares what the end result of that research is. It assumes that there will be an industry ready to pick up the pieces and to do something with it. And in fact, whether or not we would like to believe that is the case, in fact it is not the case.

The industries that exist are new. They are young. They are under-capitalized and they need some kind of help. Our history of picking winners and losers, of involving ourselves in demonstration, has not been impressive. Secretary Martin is right. But if the alternative is simply not to pick up the ball at all, then I think we pay an horrendous price, a price that we're just now beginning to appreciate, a price that other countries have assessed and that other countries have simply concluded is not worth paying. They are therefore committing serious resources to this effort.

It may very well be that a new kind of government private industry cooperation is necessary. I commend you for addressing this vexing problem in your bill. I think it deserves very careful consideration and ought not to be dismissed as simply not being appropriate for the activities of the free market. As you stated very well, the free market is fine at allocating resources but it is terrible at anticipating problems.

The result of this kind of program is probably going to be that we will fund some losers. That is, I think, an acceptable price if we fund some winners as well. Simply walking away doesn't meet the responsibilities of the next generation of users and producers. If somebody doesn't exercise foresight, we're all going to be in the soup.

I commend you for your bill. I think your bill and the bill of Senator Bumpers are important steps in the right direction. I think that particularly with the events in the Gulf these days, attention may suddenly be coming around to the fact that we may have some energy problems coming at us, and you are taking the right steps.

Thank you.

[The prepared statement of Mr. Potter follows:]

United States Senate

Testimony of

The Renewable Energy Institute

by

Frank M. Potter, Jr.
President

on

S. 1320 and S. 1554

August 6, 1987

In recent times, but before the early 1970s, energy was rarely perceived as a problem. Prices were low and predictable and the assumption of an inexhaustible supply of energy was not questioned. Suddenly and irretrievably, the world changed: prices jumped, precipitating a worldwide economic recession; the certainty of future supplies of affordable energy dwindled; and patterns of energy use changed beyond what anyone had previously believed possible.

Those events have receded in our memories, and somehow energy problems no longer seem as urgent as they once did. Gas lines and chilly winters are usually seen as events that happened in the past—problems unlikely to recur.

The events of the 1970s will not precisely reproduce themselves. But we know that the supply of conventional energy sources like crude oil and natural gas will inevitably diminish over time, and the price of these resources will rise. What we don't and can't know is how quickly and how soon. The recent review of U.S. energy vulnerability, *Energy Security: A Report to the President of the United States*, underscores this point, acknowledging, as it does, that our vulnerability to another energy upheaval is already significant and that it is increasing.

In the short term, the strategic petroleum reserves stored in Texas and Louisiana can serve an important function in buffering the U.S. and world economies from the kinds of economic shock that took place in the 1970s, but—and this is critically important—the SPR is no more than a short-term answer. It relieves some of the symptoms of the problem, but only buys us a small amount of time in dealing with the longer-term issue: how do we make the transition to a world in which conventional resources are no longer available in quantities and at prices that we can easily accept?

As conventional resources decline, we will necessarily be forced to fall back upon less conventional options—renewables and other ways of using the energy that is available to us more efficiently and less expensively. Identifying these options and their implications is what the Renewable Energy Institute is all about.

Many of these resources are older than mankind. What is new is the application of advanced technology to these sources: finding ways to meet the demands of modern consumers, and integrating new technologies to complex and integrated energy systems.

Renewable energy generally refers to energy derived from resources which are naturally replenished by the daily or seasonal cycles of the sun and earth. Solar and wind energy are two of the most commonly known, but others include biomass (wood, grain alcohol, crop residues, municipal solid waste and others) small hydropower, geothermal and ocean energy resources. Another important resource, although frequently not considered as such, is enhanced efficiency—squeezing more

useful work out of the energy that we use, and minimizing the demands that we make upon a limited resource.

These unconventional resources have been tended to be considered as mildly interesting, but not particularly relevant to the needs of the day. That perception is beginning to change, however, driven by an increased realization that the options of the past will not be available forever (in some cases perhaps not even much longer) and by new information that tells us that these resources may soon be at the point where they can effectively compete with more traditional forms of energy such as oil, gas and coal. In some cases, they are there already.

Some of these resources, such as enhanced efficiency, or conservation, are options with little or no "down side"—they have major cost advantages, and few or no disagreeable side effects. Most of the ones with which REI is concerned are far less environmentally risky than the conventional technologies, and have an additional advantage of low to almost nonexistent operating costs.

The legislation that this Committee is considering addresses itself directly to these questions, and the sponsors of these bills deserve credit for their efforts to come to grips with what has to be an important, albeit—for the moment—not particularly sexy issue.

We know that at some point in the future these issues will become once again urgent. If this were not the case, the kinds of initiative called for by these bills would no doubt be unnecessary—we could relax and let the discipline of the market, about which we have heard so much in recent times, take over. Because the marketplace will dispose of questions of *allocation* of resources very well—if you can afford it, you can have it. The corollary, of course, is that if you can't afford it, you really didn't need it anyway.

What the market will not do very well is anticipate what is likely to happen in the future—a future which is so heavily discounted in traditional government calculations that events more than seven years in the future are considered as essentially irrelevant. That may make sense in the context of classical economics—but it makes no sense at all in the case of government, one of whose principal reasons for existence ought to be to anticipate and to ease the strains of potentially devastating change in the social and economic fabric.

I have great sympathy for the objectives of the legislation which you are considering today. Like you, I am absolutely convinced that it is time, now when the sun is shining, to fix the roof. Because, when it starts to rain, it is going to rain very hard indeed.

I am not, I am forced to admit, sanguine about the prospects of any of these bills being enacted in the immediate future, nor of the likelihood of a sustained legislative or executive commitment to make funds available at the levels that they would authorize. Allocating budgets is, as we have all learned to our dismay, ultimately a question of priorities, and energy just does not rank very high on the list these days—on most lists for that matter, in either the Executive or Legislative branches of government.

I do have a suggestion. When and if this legislation, or some variant of it, is adopted, I believe that it would be a useful discipline if an additional requirement were imposed upon the agencies of government that are chosen to carry it out. That requirement would be that if the agency in question elects *not* to seek full funding for any program identified here, it should be required, within a certain number of days of the submission of the budget, to inform this Committee why it has done so.

There are countless reasons why an agency may conclude that it cannot usefully spend the money that the Congress has told it to spend. Some of these reasons are legitimate, and that money ought not to be spent. Some of them are less commendable. But I can see no legitimate reason for the agency in question not to come forward and say why it has declined to go forward. If it is a question of budgetary priorities, they can say so, just as they can in the case of social or ideological preferences.

I believe that it would be healthy for them to have to discuss these reasons publicly, and I believe that it would be useful for the Congress as well.

Senator FOWLER. Thank you, Mr. Potter, very much.

Counsel has a couple of questions.

Mr. COOPER. I just have one question. Mr. Corsi, you made a couple of remarks that I didn't see in your prepared statement about the PV-USA project. I just wanted to get the record clear on that.

Does the solar industry generally support the proposal that is before the committee for reprogramming that would allocate $2 million to the PV-USA project and reserve the remaining $5.5 million from the amount that is in the budget for 1987 for future work? Is that the thrust of your remarks? Or what was the thrust of your remarks?

Mr. CORSI. I think the original position of the photovoltaics division was that we would in fact support a PV-USA at a $7.5 million level on several provisions, one of them being that it not be done within the core photovoltaic budget.

Our position is that the $43 million that we're asking for is vital to the core R&D programs, and that those should be preserved. Taking $7.5 million of those funds to put into a demonstration project that is as regionally oriented as PV-USA is not in the best interests of the overall industry.

However, PV-USA is a thrust to help bring the credibility of photovoltaics to the utility industry at large. I think that's a worthwhile thing. What we would be able to see is to be able to work with PG&E and others who are involved in PV-USA to fund it at levels and over timeframes that are consistent with the level of funding that we're getting in total.

So we would in fact support a $2 million expenditure this year to get PV-USA going, but would look at an appropriate amount for the fiscal year 1988 budget that is consistent with the whatever funding the Congress approves overall for the entire photovoltaic budget.

Our view in general—our view in general is that we're working with very tight budgets relative to what we're trying to get done. Whenever you get funds being earmarked out of a very tight budget for very specific projects that are being done more through the political process than they are by any process of saying what is best for the industry as a whole in the eyes of people who know or at least have a great enough expertise to project how those funds might be best spent, then I think you're getting into some places where the money can in fact be wasted.

That's not necessarily the record of PV-USA, but there are several other line items in the House budget that I think it is a questionable way of allocating very scarce funds.

So, let's see. I wandered around a little bit. But specifically, yes, we support PV-USA, but we support it to the extent that it can be funded without killing the core programs that are already underway within the R&D portion of the current PV budgets.

Mr. COOPER. It sounds to me then like you support the proposal for fiscal year 1987, which is $2 million.

Mr. CORSI. Yes. My understanding is that we can in fact, out of the current fiscal budget, complete the programs underway and allocate $2 million to PV-USA. I am very concerned about taking $7.5 million out of the $43 million that we're asking for in fiscal

year 1988. And if we're cut back to $20.8, which is what the Administration proposal is, then we don't have a PV program at all. PV-USA would be, in my opinion—I don't want to say a waste of time—but it would be spending half of what is much, much, much too little to sustain a national program.

Mr. COOPER. As you know very well, Congress will be making this decision probably within the next month. So we would appreciate your recommendations for the record.

Senator FOWLER. Ladies and gentlemen, we thank you all. We would like to continue but we have a utility panel and I'm worried about the time here. So thank you all for your specificity and also your appearance.

Dr. Ian Straughan, Manager of Resources at California Edison Company in Rosemead, California; and Mr. Herbert M. Boyd, Technology Management Coordinator at the Alabama Power Company in Birmingham.

Gentlemen, thank you for your patience, and welcome.

Mr. Boyd, do you want to begin?

STATEMENT OF HERBERT M. BOYD, TECHNOLOGY MANAGEMENT COORDINATOR, ALABAMA POWER CO.

Mr. BOYD. Certainly, Senator Fowler.

I am Herbert Boyd, Technology Management Coordinator from the Alabama Power Company, a subsidiary of the Southern Company. I appreciate this opportunity to support the objectives of S. 1554, the Renewable Energy and Energy Conservation Technology Competitiveness Act of 1987, and S. 1320, the Solar Development Initiative Act of 1987. They will encourage the development of renewable technologies.

The bills provide for funding of renewable energy research and development programs during the fiscal years 1988 through 1990 so that new technologies will be available to meet our energy requirements in the years 1995 through 2000.

I would like to remind you, however, that gaps or fluctuations in funding levels will cause severe damage to R&D programs which currently exist, and will cause softening of the importance placed upon the development of new technologies. I specifically support as a minimum the authorization of $43.1 million and $50 million for photovoltaic systems for fiscal years 1988, 1989 and 1990 as provided in bill S. 1554 and in S. 1320.

As you know, Alabama Power Company has built, at its own expense, and put into operation the world's largest amorphous silicon thin film photovoltaic grid connected array, and that's a mouthful. The Southern electric system has also invested approximately $6.1 million in a photovoltaic manufacturing facility which will begin operation toward the end of 1987.

The Southern electric system has made these commitments to photovoltaic systems because it believes the direct conversion of sunlight to electricity is one of the promising options to help meet the energy demands of the country in the 1990's and beyond.

The photovoltaic industry is still very small compared with the high tech industries, and profitability is virtually non-existent. With these small revenues, the domestic industries cannot support

the necessary search to develop a scientific foundation upon which a large-scale industry can grow.

The United States is still a long way from meeting the goals set out in photovoltaic energy research and development and demonstration for P.L. 95-590. The Southern system believes that until the new technologies are developed upon which scale-up information is required, research should be directed toward the development of these new technologies.

There are a number of competitive technologies out there today, photovoltaics being one of those. But there is no clear winner among these technologies. Therefore, additional research is required on a broad range of projects aimed at improving the existing technologies.

It is the general feeling throughout the industry that there is a lot of risk associated with any solar type project, and in particular photovoltaics. But stable funding of research can remove a lot of this risk. Private industry and DOE have had a long successful partnership in developing photovoltaics and other solar energy systems.

However, recent reductions and the proposed further cuts in the DOE funding of photovoltaic research and other solar type technologies are creating severe problems in the domestic industrial leadership in all of the solar technologies.

The United States' share of the world market for commercial units fell from 64 percent in 1983 to 33 percent in 1986. Japan overtook the U.S. in shipment of photovoltaics in 1986. Europe, as you've already heard today, and India and other countries are increasing their share of the world market. This world market for photovoltaics in particular is a significant market, and we as a nation should try to maintain our strong research base to remain competitive in the world market and in our domestic markets.

So if I had to make some recommendations to you today, I would say——

Senator FOWLER. You don't have to, but we'd like it.

Mr. BOYD. In order to keep the U.S. competitive in the domestic and world markets for photovoltaics and other solar energy type technologies, we recommend that at a minimum the amounts that are provided for in S. 1554 and S. 1320 for core research be authorized. In particular, the authorization for photovoltaic demonstration projects should be separate line items and not a part of the core research.

I want to thank the sponsors of S. 1320 and S. 1554 for their interest in supporting photovoltaic research programs and other renewable energy programs. Also, in closing, I would like to stress that it is society's responsibility to insure adequate and efficient technologies to be available in the future to meet energy requirements.

Research dollars are required today if we want this to occur in the 1995 and 2000 timeframe. We, the electric utility industry, are looking to you to provide some direction and some incentive for research that needs to be done in all of these areas. The best statement you can make to our industry is that Congress will support the development of new technologies.

Thank you very much.

[The prepared statement of Mr. Boyd follows:]

STATEMENT OF HERBERT M. BOYD

S. 1554 - The Renewable Energy
and Energy Conservation
Technology Competitiveness Act of 1987

before the

Subcommittee on Energy Research and Development
of the
Senate Committee on Energy and Natural Resources

August 6, 1987

Mr. Chairman, members of the Subcommittee, I am Herbert M. Boyd, Technology Management Coordinator, Alabama Power Company, a subsidiary of the Southern Company. I appreciate this opportunity to support the objectives of S. 1554, The Renewable Energy and Energy Conservation Technology Competitiveness Act of 1987 that will encourage development of renewable energy technologies.

The bill provides for the funding of renewable energy research and development programs during fiscal years 1988-90 so that new technologies will be available to meet our energy requirements in the years 1995-2000. It is very important for new technologies to be developed for that time period since the utility industry will need additional generation at that time. In order for the new technologies to be developed by that time, research and development activities must be funded currently at sufficient levels to move the technologies forward. Gaps or fluctuations in funding levels will cause severe damage to research and development programs which currently exist and will cause softening of the importance placed upon the development of new technologies.

I specifically support, as minimums, the authorization of $43.1 million, $45 million and $50 million for the photovoltaic energy systems program for fiscal years 1988, 1989 and 1990 provided for in S. 1554.

Alabama Power Company's Involvement in Photovoltaics

The Alabama Power Company is interested in all of the renewable energy and energy conservation technologies that are being studied and has taken an active role in the photovoltaic technology. The Company, at its own expense, has built and put into operation the world's largest amorphous silicon thin film photovoltaic grid connected array. This $1 million, 100 KW demonstration unit produces enough power at the time of our system peak to meet the needs of 25 homes. In addition, Alabama Power Company management represents another subsidiary of the Southern Company, Southern Investment Group, in its joint venture with Chronar Corporation to develop a 1 MW amorphous silicon photovoltaic cell manufacturing facility in Birmingham. The Southern electric system is investing $6.1 million in the manufacturing facility which will begin opertion before the end of 1987. Alabama Power Company has made these commitments to photovoltaics because it believes the direct conversion of sunlight to electricity is one of the promising options to help meet the electric demand of the country in the 1990s and beyond.

Photovoltaic Industry

The photovoltaic industry is still very small compared with other high technology industries and profitability is virtually non-existent. It is estimated that during 1986 worldwide revenues from the sale of 27.5 MW of photovoltaic modules was

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$250 million and the United States had only 27% of the market. The small revenues of the domestic industry cannot support the necessary research to develop the scientific foundations upon which a large scale industry can grow. The partnership between DOE and the industry has produced increased conversion efficiencies and reliability. These improvements have reduced costs from $10,000 per KW in 1980-1982 to $6,000 per KW in 1986. Continued DOE support is needed for research to reduce costs further before photovoltaics can compete with other energy sources. The United States is still a long way from meeting the goal set out in the Solar Photovoltaic Energy Research, Development and Demonstration Act (P.L. 95-590) of producing 2,000 MW annually by 1990 at an average cost of 15 cents per KWH.

A better understanding of the physics of the materials being used to make photovoltaic devices will yield a higher return for the nation than additional demonstration facilities at this time. Demonstration projects cannot yield information concerning future technology. A demonstration project can only add information relating to the scale up of existing technologies. The demonstration of current technologies will yield limited or no information concerning the scale up of yet unexisting technologies. The Southern system, therefore, believes that until new technologies are developed upon which scale up information is required that research should be directed toward the development of new technologies. Technology cannot be advanced if an immature technology is found to be economically unsound and technically unreliable.

There are a number of competitive technologies in the photovoltaic area and at the present there is no clear winner among these technologies, therefore, additional research is required in a broad range of projects aimed at improving these existing technologies. In the photovoltaic area projects fall into two basic categories - basic research and development and demonstration. It is the general feeling throughout the industry that most photovoltaic projects have high risk resulting from the uncertainty of performance of the devices and the uncertainty of the price of fossil fuels. Stable funded research can remove some of this risk.

It is essential to recognize the need for development of new technology which can be utilized to expand our manufacturing sector. This sector still produces 85% of this countries wealth and that produces jobs. If the United States loses competitiveness in the manufacturing sector it risks its financial health.

DOE Research and Development

The Five Year Research Plan 1987-1991 for the National Photovoltaic program as identified by the DOE is aimed toward research which will lead to a new understanding of the mechanisms that limit the performance of thin film devices as well as in devising improvements in the production of large area modules. DOE annually allocates available funds to those options showing the greatest promise with demonstrated industrial interest and involvement. This research is divided into three areas: materials and devices research, module research and system research. This energy program is under the

direction of the Solar Energy Research Institute and the Sandia National Laboratories. These two day-to-day managers subcontract most of the research to industry, universities and other research organizations. If stable funding or sufficient funding does not exist then the contractors lose interest in the programs and damage is done to existing programs as well as future programs.

Private industry and DOE have had a long and successful partnership in developing photovoltaic energy systems. However, recent reductions and proposed further cuts in DOE's funding of photovoltaic research and development are creating serious problems in the domestic industry's leadership in photovoltaic technology. DOE's funding for research and development increased from $3.5 million in FY 1974 to $150 million in FY 1980. However, since 1980 there has been a sharp downward trend in DOE funds for photovoltaic research and development, and for FY 1986 and FY 1987 it was $40 million.

The proposed authorizations in S. 1554 of $43.1 million for FY 1988, $45 million for FY 1989 and $50 million for FY 1990 for the photovoltaic energy systems program are minimum amounts needed to continue the basic needs if the United States is going to be able to successfully compete for sales in the domestic and overseas markets.

Foreign Competition

United States producers of photovoltaic cells have concentrated their research efforts on developing technology for commercial photovoltaic units while the Japanese have taken the lead in consumer units for watches and calculators. However, as

shown in the following table, United States shipments of commercial cells since 1983 have been declining while shipments by other countries have been increasing. The United States' share of the world market for commercial units fell from 64% in 1983 to 33% in 1986 and Japan overtook the United States in shipment in 1986. Europe, India and other countries have also increased their share of the world market on both an absolute and relative basis.

World Photovoltaic Commercial Cell Shipments

(MW)

	1983	1984	1985	1986
United States	9.3	8.4	7.5	7.2
Japan	2.8	5.3	6.4	8.2
Europe	2.2	2.9	3.7	3.4
India/Other	.3	.8	1.8	3.2
TOTAL	14.6	17.4	19.4	22.0

World shipments of consumer modules have followed the same pattern from 1983 to 1986 with United States shipments falling from 3.8 MW in 1983 to .3 MW in 1986 and foreign shipments increasing from 3.3 MW to 5.2 MW during the same period.

The potential world market for photovoltaics is great and the United States needs to maintain a strong research base to remain competitive in the world and domestic markets. The projected world market should increase from 27.5 MW valued at $330 million in 1986 to 150 MW valued at $1,350 million in 1991. Other countries are expanding their photovoltaic research activities. If we do not maintain sufficient funding for our

research programs, it is clear that Japan and the other countries will gain a competitive advantage and the United States will become a buyer, not a seller, of the technology in the world market place.

Recommendations

In order to keep the United States competitive in the domestic and world markets for photovoltaics, we recommend as a minimum the amounts provided for in S. 1554 for core research programs. The authorization for photovoltaic deomonstration projects should be a separate item.

I want to thank the sponsors of S. 1554 for their interest in supporting photovoltaic research programs and other renewable energy programs. Also, in closing, I would like to stress that it is society's responsibility to insure adequate and efficient technologies are available in the future to meet its energy requirements. Research dollars are required today if we want this to occur by the 1995-2000 timeframe. We, the electric utility industry, are looking to you to provide continued direction and incentive for the research that needs to be done in photovoltaics. The best statement you can make to our industry is that Congress will continue to support the development of new energy producing technologies.

Thank you very much.

Senator FOWLER. Thank you very much, Mr. Boyd, for that testimony and for that support for consistent stable funding if we are to achieve the common goals.

Dr. STRAUGHAN. Did I pronounce it right?

Dr. STRAUGHAN. Yes. Thank you for pronouncing it right.

Senator FOWLER. With a name like Wyche, I try to pronounce things right. Welcome.

STATEMENT OF DR. IAN R. STRAUGHAN, MANAGER OF RESOURCES, SOUTHERN CALIFORNIA EDISON CO.

Dr. STRAUGHAN. Thank you. I am Ian Straughan and I am manager of Resources at the Southern California Edison Company. It is indeed a pleasure for me to be here this afternoon to support both of these bills.

I'd like to address the questions that you presented to us.

Senator FOWLER. Please.

Dr. STRAUGHAN. I will condense them into your own statement that we have to get the hay to where the goats can get at it. I think my company has proven that it's about the hungriest goat around because we're certainly the leader in the adoption of renewable technologies, particularly those that have been developed through the most recent of our national programs.

I have a prepared statement which I respectfully submit, and I would like to summarize and illustrate with a few examples in my oral remarks.

The Southern California Edison Company is situated to take advantage of renewables probably better than most because in geothermal the Saudi Arabia of geothermal happens to be the Imperial Valley, which is just to the south of our service territory. Most of our service territory in southern and eastern California lies in the desert, where we get at least 100 to 150 mutants per square meter of solar radiation, and in some part over 150.

We did a little exercise that I think demonstrates the potential for the nation as a whole, and particularly for our utility, of solar power. Our entire system as it stands today has a capacity for 17 gigawatts. Looking at just the land available from the Bureau of Mineral Resources—that is flat land in the desert that Senator Cranston doesn't want to create into wilderness or turn into wilderness or national parks——

Senator FOWLER. No, he does want to.

Dr. STRAUGHAN. No. This is land outside of even what he would turn into a national park. We found that we had 2 million acres that was readily available to us, had water and access and everything else.

We look at that 2 million acres—With present day technology such as we have demonstrated at our solar I, we could build a 200 gigawatt system on that 2 million acres. If we go to the next level of technologies—and these are the technologies that I think your bill and the attendant bill speak to—those are the technologies that we see as being mid-term technologies that are in need of support for demonstrations—that's the advanced PV molten salt central receiver and the parabolic dish sterling engine technologies—-

that's with about a 20 percent conversion efficiency—we'd have a 400 gigawatt system.

If we went all the way to the photovoltaic systems, particularly advanced concentrating photovoltaics, we're talking about a 600 gigawatt system. So I just give you these numbers to emphasize the huge potential and the potential energy security of renewable resources.

Senator FOWLER. Where do you think your company, Southern California Edison, how soon would it get to that second and third level in your descriptions of the energy potential without any government help?

Dr. STRAUGHAN. When or how?

Senator FOWLER. First whether, and then when.

Dr. STRAUGHAN. No. I don't think that we would be able, or we're not in the position to take that risk because those technologies have not yet been sufficiently demonstrated to be at an acceptable level of prudent risk for a utility to take.

In other words, we wouldn't invest the shareholders' capital in those systems because if there were some problems and they didn't work up to expectations, we would not be able to recover those costs.

So that is why we support your initiative here, because we believe that that will bridge the gap between where the technologies are today and where they need to be before we feel it prudent to adopt them on our electrical system.

Thank you.

[The prepared statement of Dr. Straughan follows:]

Prepared Testimony

of

DR. IAN R. STRAUGHAN
Manager of Resources
Southern California Edison Company

CONCERNING SENATE BILL S1320
"The Solar Development Initiative Act of 1987"
AND SENATE BILL S1554
"Renewable Energy and Energy Conservation
Technology Competitiveness Act of 1987"

Before the
Subcommittee on Energy Development and Applications

of the

Committee on Energy and Natural Resources

of the

United States Senate
Washington, D.C.

August 6, 1987

Good morning, Mr. Chairman and members of the Subcommittee. It is indeed a pleasure for me to appear before you to discuss the need to continue the Department of Energy's Research and Development of Renewable Energy Systems with long range stable funding.

I am Ian R. Straughan, Manager of Resources at Southern California Edison Company. My responsibilities include the implementation of strategies to integrate Renewable Energy systems into our supply side planning, and to incorporate energy conservation into our demand side management. Prior to holding this position, I was Director of Research and Development and had responsibility for the development and demonstration of Renewable Energy Technologies on the Edison system.

First, a few facts about Southern California Edison and why we have a particular interest in the future of Renewable Technologies. Southern California Edison serves a 50,000 sq. mile territory in southern and central California with about 3 1/2 million customers. In our 100 years of service (1986 was our centennial) we have a history of technological innovation in generation, transmission and end-use. In 1971, we were one of the first utilities to formalize our research and development efforts into a central organization, and to begin collaborative RD&D with federal agencies and the newly formed Electric Power Research Institute (EPRI).

I would like to emphasize the importance of the interaction among the research, development, demonstration, and commercialization players in a successful national program.

In June of 1984, I had the privilege to testify to the House Subcommittee on Energy Development and Application on the federal demonstration program in Renewable Energy (copy attached). The analogy to a four lap relay race that I used then, can also be used to illustrate the need for steady long-term financial commitment. The first two laps are the basic research and bench scale development stages which can be very successful carried out by DOE without interaction with other players. However the final lap, commercialization, requires a player form the private sector who has to be committed to the race and willing to accept the technological baton being passed on. It is not sufficient to recruit the private sector at the last movement because there is still a third, demonstration, lap to be run and baton must be passed on in an orderly manner. Early recruitment of the private sector is an essential component in selection and training of the runners for all four laps. Where this has been done in the past, the nation has benefited from some very successful federally sponsored programs.

Even with the best of coordinated programs, funding is a consistent problem. As the program passes from basic research to bench scale, to pilot scale, to full scale demonstration, the

costs of continuing keep escalating because full scale demonstration are, by their nature, for more expensive than basic or bench scale experiments. However, as technology reaches the demonstration phase, the base of interest in applications should become broader. If this is not so, that technology should be dropped. Successful Renewable technological development by DOE often with EPRI co-sponsorship or support has led to a broad base of utilities' commitment to the demonstration and deployment of the technology. That is, as the cost increased with progress, sharing of costs on a broader base helps to levelize the financial commitment by DOE. However consistent funding by DOE is essential to the final success.

The flip side of this well structured and consistently funded "perfect" world is the real world. Unfortunately, the trickle down economic theory applies to RD&D programs on the down-swing as well as the up-swing. The impact of reducing DOE funding, particularly precipitous cut backs, sends a ripple through the private RD&D support structure that tends to magnify in passage. I have illustrated this by comparing the recent history of DOE, EPRI, and Southern California Edison expenditures for Renewable Energy Research (Figures 1-3). The Advanced Power Systems at EPRI and the Edison research program include alternative energy system RD&D as well as renewable, but serve as good indices of industry financial commitment to renewable energy RD&D.

FIGURE 1

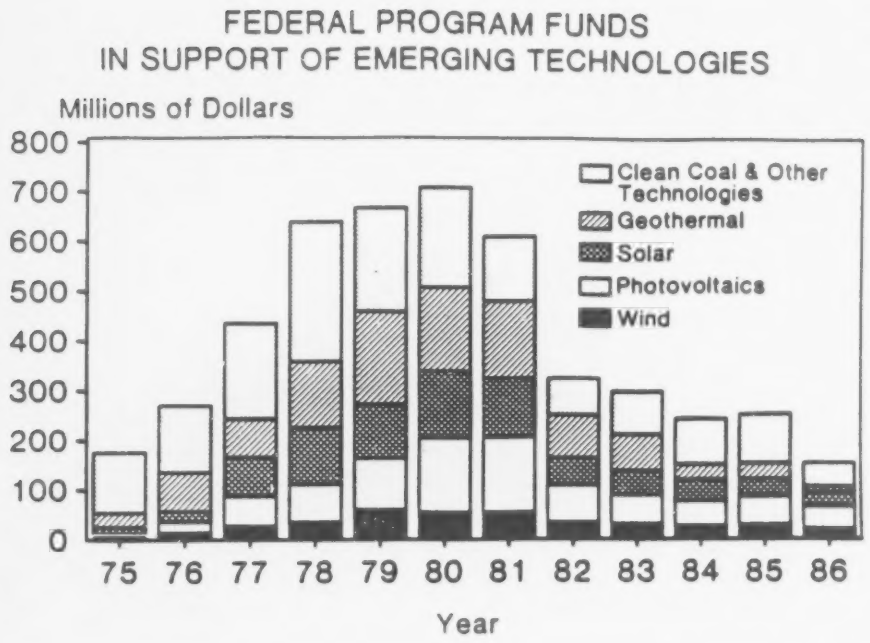


FIGURE 2

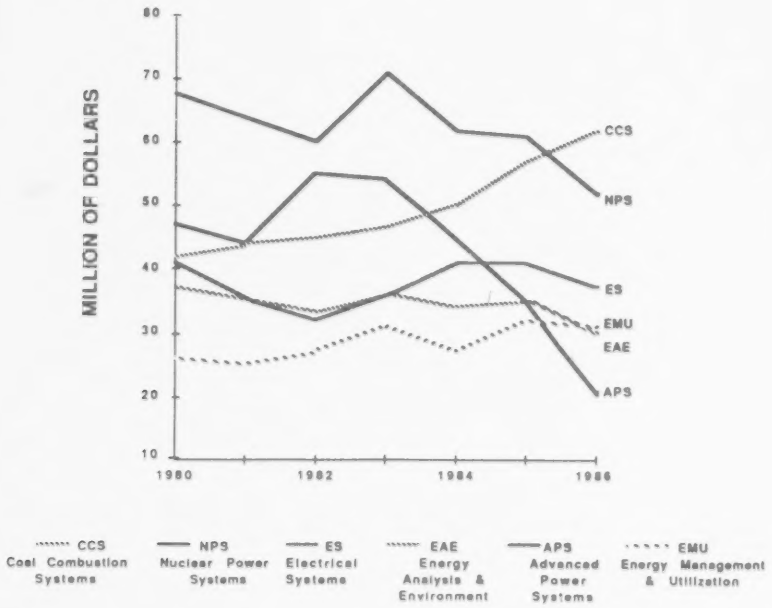
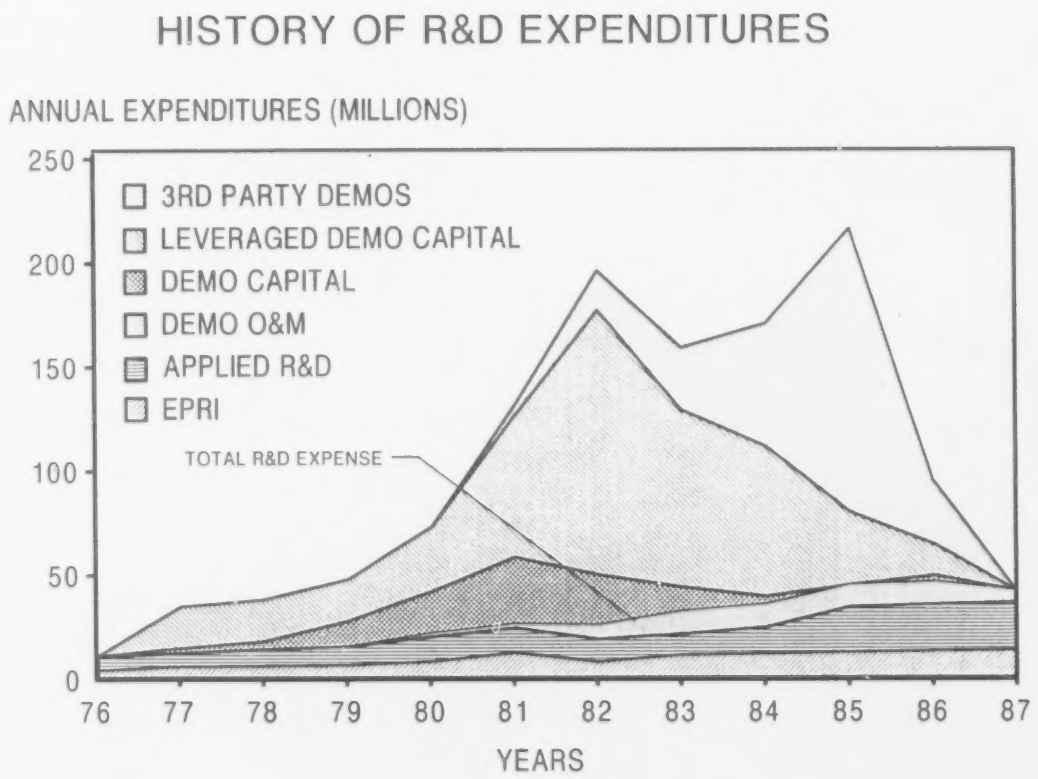


FIGURE 3


HISTORY OF R&D EXPENDITURES
ANNUAL EXPENDITURES (MILLIONS)
250
200
150
100
50
0
3RD PARTY DEMOS
LEVERAGED DEMO CAPITAL
DEMO CAPITAL
DEMO O&M
APPLIED R&D
EPRI
TOTAL R&D EXPENSE
76
77
78
79
80
81
82
83
84
85
86
87
YEARS

Without federal support, the private sector cannot afford the risks associated with application of new technologies, particularly in the regulated utility industry. For renewable energy systems, the recent history boom-and-bust RD&D does have an underlying cause.

The energy crisis of the seventies stimulated general support for providing alternatives to energy systems based primarily on oil. At the peak of support and RD&D activity in 1980, Renewables provided great promise. Figure 4 depicts the concensus projection of oil prices and the expected equivalent electricity prices from renewable and alternative technologies (shaded). By the mid-eighties, the more advanced of the technologies would be cost competitive with oil, and just about anything would beat oil by the turn of the century.

Events did not bear out our expectations. The fall in oil prices has meant that these technologies are not cost competitive will oil now and may not be until the end of the century (Figure 5).

However, oil prices will inevitably rise and the crossover to cost advantage of renewable energy systems is only a matter of time, provided we continue progress toward developing these technologies.

FIGURE 4

1980
OIL PRICE PROJECTIONS &
COST GOALS FOR NEW TECHNOLOGIES

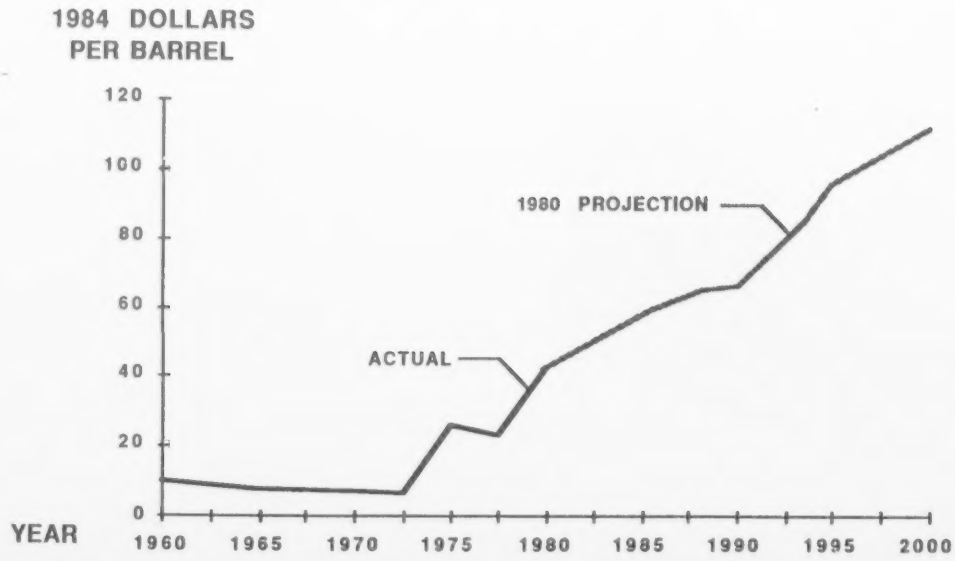
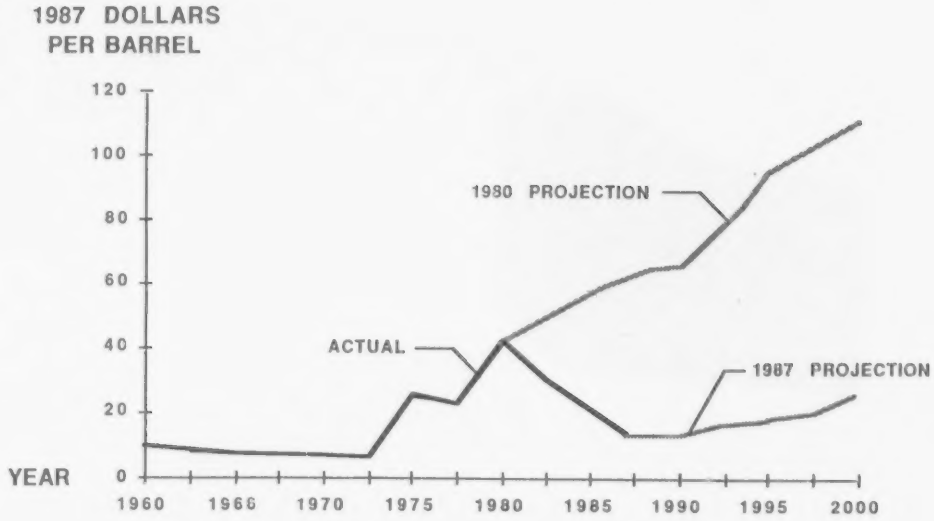


FIGURE 5

1987
OIL PRICE PROJECTIONS &
COST GOALS FOR NEW TECHNOLOGIES



The crisis driven effort of the late seventies and early eighties provided a shifting of concepts that showed great potential for some and limited applications for others. Now that we have the luxury of time to systematically develop those promising technologies, I urge the Congress to adopt a long-range commitment that will provide sufficient funding to carry these technologies through to adoption in our future energy mix before the next crisis arises.

Senator FOWLER. Thank you both very much.

Let me ask you this. This is not to put you on the spot, and I know it will involve a crystal ball. But because you are fine representatives of the utility industry I would be personally interested in your projections of the industry's—I'm trying to figure out the right word I want to use—reliance on nuclear power over the next ten to 20 years. Will it increase? Will it diminish? How do you see the future of your company's as far as the energy mix to serve your quasi- public charter as well as your consumers?

Do you want to start, Mr. Boyd?

Mr. BOYD. I will. Senator Fowler, I think, as you probably know, the electric utility industry as a whole, with the attending risk associated with nuclear today unless some things change in the political structure associated with being able to recover capital and put the units in rate base and being able to actually earn all those dollars you invest, that most utilities will tell you that they will not have a heavy reliance on nuclear power in the future until those situations change.

If those situations were to change you might see some difference in that philosophy. I think that the Southern system is a typical example. I don't think that we have any nuclear plants after the Volvo units in our generation mix. They are all fossil and other forms of energy.

Senator FOWLER. Plus the fact that they cost so much.

Mr. BOYD. There is too much risk associated with those costs. There is no way that you can build a nuclear plant with changing regulations for the target dollar that you estimate at the point that you initiate construction. There is no way.

Dr. STRAUGHAN. Senator Fowler, maybe as Edison's chief planner I might be able to provide some insights into why nuclear won't be in our future. It's very simple.

The only thing that we can say for certain about our future in terms of our loads and the resources that we will need to meet those loads is that it's uncertain. In face of uncertainty, we need to have technologies that can be brought on in a very short lead time, not only from the point of view, as Mr. Boyd pointed out, of the risk of having capital out there at risk for a long time before it can be recovered, but just on the simple practicality of trying to match the resources to the load growth.

When the load growth is uncertain, the longer lead time and larger plant that you have the less certainty there is that that will actually meet that future load. The load will be something quite different than what you build for.

So our plans are to maintain maximum flexibility with small increments of modular technology which renewable technology fortuitously fits in terms of its characteristics.

Mr. BOYD. I would like to confirm exactly what Ian said on that, Mr. Fowler. We all look at that same thing as far as trying to match the generation to the load. That's the reason we're looking at a lot of smaller type size generation resources.

Senator FOWLER. Gentlemen, thank you very, very much for being with us all day. Somebody had to be last. It's never easy. Thank you so much.

I thank all of you for coming today and all of our witnesses. We stand adjourned.

[Whereupon, at 3:26 p.m., the hearing was adjourned.]

[Subsequent to the hearing the subcommittee received the following statement:]

THE COMMONWEALTH OF MASSACHUSETTS
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COMMENTS OF EVELYN F. MURPHY, LIEUTENANT GOVERNOR

COMMONWEALTH OF MASSACHUSETTS

TO THE

U. S. SENATE COMMITTEE ON ENERGY AND NATURAL RESOURCES

SUBCOMMITTEE ON ENERGY RESEARCH AND DEVELOPMENT

IN SUPPORT OF S.1320 AND S.1554

August 20, 1987

As Lieutenant Governor of the Commonwealth of Massachusetts, I would like to reiterate the Commonwealth's support for two bills: S.1320, "The Solar Development Initiative Act of 1987" and # S.1554, "The Renewable Energy and Energy Conservation Technology Competitiveness Act of 1987."

As the Commonwealth's Energy Secretary Sharon Pollard testified before the Committee on August 6, Massachusetts was more adversely affected by the oil shocks of the 1970's than any other state in the nation. In 1972, Massachusetts consumed 225 million barrels of oil, which represented 89% of its total energy needs. As the result of market forces,

aggressive conservation efforts, and conversion of oil-fired power plants to alternative fuels, oil consumption ten years later had dropped to 135 million barrels, a reduction of 40%. During the same period, Massachusetts increased its use of renewable energy resources by 68%.

The Commonwealth's efforts to reduce its dependency on imported oil were complemented in the late 1970's by federal energy policies and programs that promoted the use of renewable energy resources. Federal tax incentives and funding for renewable energy research and development could be coupled with state tax incentives and programs to make renewable energy sources cost-effective investments for businesses, for government institutions, and for private citizens.

I am pleased to report that, in 1987, Massachusetts has continued its aggressive support of renewable energy resources. Perhaps our most notable achievement has been the establishment of the Massachusetts Photovoltaic Center, the first of its kind in the nation. The Photovoltaic Center is one of the Commonwealth's four "Centers of Excellence"; which are designed to foster innovation at the cutting edge of science and technology, and to help businesses engaged in promising

new technologies to compete in the global economy. The Photovoltaic Center of Excellence consists of four components:

- a demonstration center offering an orientation to foreign visitors on PV technology and displays exportable PV systems;

- an export assistance service provides global market information to PV companies identifying potential worldwide clients;

- a technology service that offers foreign clients an opportunity to consult with professors and engineers on PV applications and receive training on PV systems maintenance and operations under the guidance of the University of Lowell; and

- financial services offering a reference library and professional assistance in locating and arranging financing for PV projects. It also provides information on federal and international lending and development agencies to foreign nationals who wish to purchase a PV system.

While Massachusetts has continued and in fact strengthened its leadership role in promoting renewable energy, the federal government has been reducing and apparently abandoning its commitment. Under the Reagan

Administration, the federal budget for renewable energy programs has been reduced by over 80% between 1981-1987. In 1981, $777 million in funds were allocated to solar energy and other renewable energy appropriations. The 1988 energy budget proposes to reduce this funding to $94 million, a level which is wholly inadequate and painfully shortsighted.

Photovoltaic technology is proven and cost-effective for a broad array of applications. The photovoltaic industry in the United States, with federal and state government support, has made tremendous progress in reducing costs and increasing efficiency of PV cells. But continued federal government support of the kind envisioned in S.1320 and S.1554 is essential if the industry is to bring costs down to a level where photovoltaics is not only a significant component of the nation's energy supply, but a major American export product.

Despite the current Administration's disheartening attempts to reduce renewable energy funding to a meaningless level, those of us who truly care about our nation's long-term energy security can be encouraged by the direction and leadership shown by the sponsors of S.1320 and S.1554. I urge the Committee's favorable action on these bills, and I thank the members of the Committee for their courage and their foresight on energy issues that are vital to our nation's well-being.

APPENDIX

Responses to additional Committee Questions

POST-HEARING QUESTIONS AND ANSWERS

Relating to the

August 6, 1987 Hearing

Before the

COMMITTEE ON ENERGY AND NATURAL RESOURCES

SUBCOMMITTEE ON ENERGY RESEARCH AND DEVELOPMENT

UNITED STATES SENATE

WITNESS: WILLIAM MARTIN
DEPUTY SECRETARY
U.S. DEPARTMENT OF ENERGY

QUESTIONS FROM SENATOR DOMENICI

Question 1: What is the electric utility interest today in renewable energy systems?

Answer: In the decade of the 80's, utility use of renewable energy has more than tripled. The Investor Responsibility Research Center has estimated that by 1990 installed renewable capacity will exceed 14,000 MW. Today, over 40 utilities are using, testing, or experimenting with photovoltaic systems. Over 100 utilities are using wind systems, dozens of biomass systems are in use, significant amounts of geothermal energy are being supplied in California, and major solar thermal facilities are currently being built. Inevitably, this usage will increase even further as additional advances are made through research and development.

QUESTIONS FROM SENATOR DOMENICI

Question 2: Is DOE aware of any major commercial investment in modern renewable energy systems?

Anwer: A major advancement in the development and use of solar thermal electric systems is currently in progress. The LUZ Corporation has built and operates, for the Southern California Edison (SCE) Utility, four power plants totaling 103.8 MW, has another 30 MW plant under construction, and has plans to build several more. LUZ has signed an agreement with SCE to supply a total of 550 MW by the end of 1992. This is the largest and most substantial undertaking of this technology in the world. Additionally, the ORMESA Partnership has constructed a 30 MW geothermal power plant and has started construction of a second 20 MW plant in southern California. Also some 40 power plants are currently under construction that would use municipal wastes as their power source. In total, these represent very substantial commercial investments in renewable energy systems.

QUESTIONS FROM SENATOR DOMENICI

Question 3: I have been told that the U.S. has fallen behind Japan in the development and sale of photovoltaics. Since this was a technology invented in America, this is very disturbing. What is the status of the U.S. in this competition and how can it be improved?

Answer: Although the Japanese have increased their share of the world PV market, primarily through sales of PV-powered consumer products, they are still far behind the U.S. in producing large-scale PV power modules. Overall, when watches, calculators, and similar products are included, it is estimated that the U.S. share of the total market is 35 percent and the Japanese share is 45 percent. However, in the important and potentially much larger power applications market of interest to utilities, U.S. shipments of PV products are estimated to be about double that of our nearest competitor.

U.S. industry benefits from both continued DOE cooperative research and development programs in photovoltaics and market assistance activities of the inter- agency Committee on Renewable Energy Commerce and Trade (CORECT). For example, to prevent stop-and-go research, DOE has made three-year commitments to PV R&D projects. In May of this year, DOE and CORECT sponsored a major international conference on PV applications and financing opportunities for U. S. companies. We are confident that such collaboration between government and industry will have positive results and improve U.S. standing in worldwide sales.

QUESTIONS FROM SENATOR DOMENICI

Question 4: I recall that there have been previous DOE activities to promote the use of Renewable Energy in Federal facilities. What have been the results of these programs?

Answer: Major efforts to utilize renewable systems in Federal programs or facilities have occurred in the building and photovoltaic technology areas.

The Solar in Federal Buildings Program (SFBP), authorized by the National Energy Conservation Policy Act, resulted in 706 solar systems installed in buildings owned by 14 different Federal agencies. Systems ranged from small domestic hot water systems for residential buildings to large solar space heating systems. The SFBP is conducted in cooperation with industry and has provided substantial experience to Federal agencies in the procurement and operation of solar systems.

The Federal Photovoltaic Utilization Program (FPUP), sponsored by the Department of Energy, provided an opportunity for 26 Federal agencies to install photovoltaic power systems in various types of applications and environments. Several follow-up applications have been stimulated. For example, as a result of its experience under this program the Coast Guard recently announced the expanded commitment to purchase 15,000 PV powered navigational aids.